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Surface Aviation Observations

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6010 EXECUTIVE BLVD., SUITE 900
ROCKVILLE, MARYLAND 20852

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CHANGE AND REVIEW LOG

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Changes are indicated by a vertical line in the margin next to the change.

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FOREWORD

In 1988, the Office of the Federal Coordinator for Meteorology (OFCM) assumed responsibility for preparing and maintaining Federal Meteorological Handbook No. 1 (FMH-1). The task of accomplishing preparation and coordination was assigned to the Ad Hoc Group for FMH-1 (AHG/FMH-1) through the Working Group for Surface Observations under the Committee for Basic Services (CBS).

This fourth edition of FMH-1, "Surface Aviation Observations," concludes the 5-year effort by the AHG/FMH-1 to meet the objectives outlined in guidance issued by CBS. Specifically, CBS directed that the new FMH-1 should: (1) acknowledge the use of automated surface weather observing systems; (2) integrate conventional and automatically observed data by adopting new standards for automated, augmented, and manual observations; (3) allow agencies to prepare and issue agency-specific procedures and instructions for taking and reporting surface aviation weather observations; and (4) combine FMH-9, "Aviation Weather Observations" with FMH-1.

In previous editions of FMH-1, all procedures and internal instructions pertaining to surface weather observations were described in that one document. Beginning with this edition, FMH-1 will contain only Federal standards; it will not contain agency-specific procedures and practices. In the near future, the Departments of Commerce, Defense, and Transportation will issue observing handbooks for their respective agencies. These handbooks will comply with the standards adopted in FMH-1 but may vary with respect to the manner in which these standards are met.

I would like to acknowledge the efforts put forth by members of the AHG/FMH-1, past as well as present, who diligently labored and persevered to produce this document. Interagency coordination, especially the establishment of new standards which have impacts on policies and procedures, is an extremely difficult task and worthy of special recognition. I commend the AHG/FMH-1 members for their efforts.

Julian M. Wright, Jr.
Federal Coordinator for Meteorological
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CHAPTER 1

INTRODUCTION

1.1 Purpose.

Federal Meteorological Handbook No.1, *Surface Aviation Observations* (FMH-1) prescribes weather observing standards applicable to all Federal agencies engaged in taking and reporting surface aviation observations (SAO). It also prescribes the standard reporting and coding procedures used to develop the SAO either manually or by an automated weather observing system. These standards do not inhibit agencies from doing more than is specified. FMH-1 is consistent with agreements with the World Meteorological Organization (WMO), the International Civil Aviation Organization (ICAO), and civil as well as military weather services.

This Handbook is applicable to stations taking the following types of observations:

- **automated observations** - automated surface weather observing systems that prepare the SAO for transmission but with no certified weather observers.
- **augmented observations** - automated surface weather observing systems that prepare the SAO for transmission and with certified weather observers signed onto the system to add information to the observation.
- **manual observations** - certified weather observers are responsible for the SAO that is transmitted.
- **backup observations** - a method for providing an SAO, part of an SAO, or documentation/communications of an SAO when the primary automated method is unavailable.

1.2 Applicability of Standards.

Procedures and practices described in this Handbook are applicable only if a station has the capability to comply with the stated standard. For example, none of the procedures nor practices described in Chapter 3, Sky Condition, apply to a non-augmented, automated station that does not have a ceilometer.

1.3 Designated Stations.

Throughout this Handbook the phrase "designated stations" appears. This phrase refers to weather observing stations that have been instructed by their responsible agency to perform a specified task that is not required by these standards to be performed at all stations.

1.4 Relation to Other Handbooks and Manuals.

Individual agencies shall issue their own manuals defining their observing procedures which implement the FMH-1 standards. Such manuals shall complement, not change, the instructions contained in FMH-1. Most observing standards described in this Handbook also apply to synoptic surface observations which have coding and reporting procedures described in Federal Meteorological Handbook No.2, Surface Synoptic Codes (FMH-2).

1.5 Format of This Handbook.

Chapter 1 presents an introductory overview of the Handbook.

Chapter 2 discusses the surface weather observing program, general observing standards, and types of observations.

Chapters 3 through 8 focus on a specific element (e.g., Visibility is an element) and all the associated parameters (e.g., Prevailing Visibility and Sector Visibility are visibility parameters) of that element that appear in the weather observation. The elements are: Sky Condition (Chapter 3), Visibility (Chapter 4), Weather and Obstructions to Vision (Chapter 5), Pressure (Chapter 6), Temperature and Dew Point (Chapter 7), and Wind (Chapter 8). Each chapter has a similar format: a brief overview of the chapter, a section that defines observing and reporting standards and procedures that generally apply to all stations, and a section that defines further the observing and reporting standards for each of the three types of observations--automated, manual, and augmented.

Chapter 9 defines the coding and dissemination procedures for observations in the SAO format. It also describes procedures for correcting observations.

Chapter 10 presents the certification and quality control standards. It discusses certification of observers and quality control performed on-site, and at remote locations.

Chapter 11 defines the requirements for maintaining records of surface weather data. It discusses the types of records, the preparation and maintenance of the Station Information File, types of storage, and procedures for maintaining records of surface weather data.

Appendix A is a Glossary.

Appendix B is a list of acronyms and abbreviations.

Throughout this Handbook, the following definitions apply:

- "shall" indicates a procedure or practice is mandatory
- "should" indicates a procedure or practice is recommended
- "may" indicates a procedure or practice is optional
- "will" indicates futurity; it is not a requirement to be applied to practices.

1.6 Changes to The Handbook.

Changes, additions, deletions, and corrections will be issued, as necessary. These changes shall be issued only by the Office of the Federal Coordinator for Meteorology (OFCM) after consultation and coordination with the Working Group for Surface Observations (WG/SO).

1.7 Agency Procedures and Procedural Changes.

Agencies shall issue manuals and directives to provide more detailed instructions and training to their personnel and users (see paragraph 1.4). Copies of these procedures shall be provided to the reference library (see paragraph 1.8). Agencies may also issue changes to their procedures as follows:

- Routine procedural changes that are in conformance with FMH-1 may be issued by an agency at any time without coordination with the WG/SO.

- Procedural changes not in conformance with FMH-1 shall be coordinated with the WG/SO when time allows. However, when necessary to meet urgent requirements, procedural changes not in conformance with FMH-1 may be issued by an agency without coordination with the WG/SO. Copies of changes shall be forwarded to the WG/SO for coordination and appropriate action.

1.8 Reference Library.

The WG/SO shall maintain a record and library of agency procedures, changes, and supplements issued by all participating agencies. The WG/SO shall establish a procedure for making these procedures, changes, and supplements available to users.

1.9 Unforeseen Requirements.

No set of instructions can cover all possibilities in weather observing. The observer must use his own judgment, adhering as closely as possible to this Handbook and agency operating procedures, to describe phenomena not adequately covered by specific instructions. If the observer believes Handbook procedures require change or clarification, suggested changes should be sent through normal administrative channels to the headquarters of the appropriate organization.

1.10 Other Questions and Suggestions Regarding FMH-1.

Questions or suggestions about the content or organization of this Handbook should be directed to:

Office of the Federal Coordinator for Meteorology
8455 Colesville Road, Suite 1500
Silver Spring, MD 20910

Telephone: Commercial (301) 427-2002

CHAPTER 2

SURFACE AVIATION WEATHER OBSERVATION PROGRAM

2.1 Surface Aviation Weather Observations Program.

Surface weather observations are fundamental to all meteorological services. These observations are used for forecasts and warnings and to support a wide range of weather sensitive activities.

The Departments of Commerce (DOC), Defense (DOD), and Transportation (DOT) have established networks of stations that collectively provide the meteorological data used to perform the above services. As the Nation's primary civil meteorological agency, the DOC's National Weather Service (NWS) has the responsibility for observing, analyzing and forecasting weather conditions. DOD organizational elements within the U. S. Air Force (Major Commands), Marine Corps, and Navy (Naval Meteorology and Oceanography Command (NAVMETOCCOM) and afloat aviation divisions) take aviation weather observations to support DOD operations world-wide. In addition to taking observations, the DOT's Federal Aviation Administration (FAA), as the agency responsible for safe operation of aircraft and efficient use of the Nation's airspace system, has the role of establishing requirements for, and disseminating aviation weather data to airspace users.

In addition to the observations taken by the above Federal agencies, observations are taken by commercial airline companies, private individuals, and local and state government agencies. These non-Federal locations are established and operated under the guidance of the NWS, in cooperation with the FAA.

2.2 Surface Aviation Weather Observing Locations.

There shall not be more than one official SAO for an airport at any one time. For meteorological observations, the observing location is defined as the point or points at which the various elements of the observation are evaluated. For example, at a large modern airport, the locations may be defined as follows:

- For clouds, surface visibility, weather and obstructions to vision, the observing location may be at the touchdown area of the primary runway.
- For tower visibility, the observing location shall be the Airport Traffic Control Tower (ATCT).
- For temperature, dew point, and wind, the observing location may be the center of the runway complex.
- For reporting lightning, the location, type, and frequency of lightning will be referenced to the center of the airfield according to the procedures listed in paragraph 9.7.3.12.

Specific details on the siting of observing equipment can be found in the Station Information File (see paragraph 11.2.1).

Weather observations may also contain information on phenomena occurring at other than the station, such as "clouds over mountains NW", "lightning SE", etc. In these cases, the point(s) where the phenomenon occurs is not considered to be an additional observing location.

2.3 Automated Surface Weather Observing Systems.

The automated systems referred to in this Handbook are highly sophisticated data sensing, processing, and dissemination systems. The systems use an array of sensors to evaluate sky condition, visibility, pressure, temperature, and wind. At many stations, additional sensors are used to evaluate weather phenomenon and .obstructions to vision. The automated systems process sensor data at least once a minute and, using appropriate integration times, produce a weather observation. These minute-by-minute observations are, in many cases, automatically broadcast over radio to pilots in the vicinity of the station; are displayed on monitors in operations offices on the airport; and are available by dial-in telephone. The systems may also use the minute-by-minute data to generate and disseminate the surface aviation observations defined below.

2.4 Surface Aviation Observations (SAO).

The SAO is the primary observation used in the United States to satisfy requirements for reporting surface meteorological data. These data are primarily reported in an alphanumeric code formatted for aviation users. A complete SAO contains a report of sky condition, visibility, weather and obstructions to vision, sea-level pressure, temperature, dew point, wind, and altimeter setting collectively referred to as "the body of the report". In addition, significant information elaborating on data reported in the body of the report, or coded and plain language data not included in the body of the report, may be appended to the report in a section referred to as "Remarks." However, the content varies according to the type of weather station. At designated stations, the SAO may be abridged to only include one or more of the above elements. Table 2-1 defines the types of stations that take SAOs. In addition to the stations defined in Table 2-1, SAOs are taken by Automatic Meteorological Observing Stations (AMOS), Remote Automatic Meteorological Observing System (RAMOS), and Automated Observing Stations (AUTOB). Table 2-2 summarizes the content of SAOs at various types of stations.

2.4.1 SAO Long-line Transmission Schedule. With the exception of designated stations which shall transmit observations in accordance with agency instructions, SAOs shall be transmitted every hour with unscheduled observations transmitted when any of the criteria in paragraph 2.4.3.4 occur. Each station's schedule for transmitting SAOs shall be included in the Station Information File (paragraph 11.2.1).

Table 2-1. Types of Stations Transmitting SAOs

Type of Station	Definition
AO1	Automated station without precipitation discriminator.
AO1A	Automated station without precipitation discriminator with augmentation capability and an observer signed on.
AO2	Automated station with precipitation discriminator.
AO2A	Automated station with precipitation discriminator with augmentation capability and an observer signed on.
Manual	Station where human observer has complete responsibility for observation.

2.4.2 Record or Record Special Observations (SA or RS). A Record observation (SA) is the scheduled SAO. At designated stations, the 0000, 0600, 1200, and 1800 Coordinated Universal Time (UTC) Record observations include additional data specified by the responsible agency and are known as 6-hourly observations. At designated stations, the 0300, 0900, 1500, and 2100 UTC observations are known as 3-hourly observations and also contain additional information specified by the responsible agency. Record observations which also meet the criteria for a Special observation, given in paragraph 2.4.3.4, are called Record Special observations (RS).

2.4.3 Special Observations (SP). A Special observation (SP) is an unscheduled observation taken when any of the criteria given in paragraph 2.4.3.4 have been detected. All specials shall be taken as soon as possible after the relevant criteria are observed. The criteria are only applicable to stations that have the capability of evaluating the event. For example, visually evaluated elements, such as a tornado, are not applicable to non-augmented, automated stations. Special observations include record, aircraft mishaps, single element, and urgent specials, and shall be taken at designated stations.

2.4.3.1 Content of Special Observations. Except as described in paragraphs 2.4.3.3 and 2.4.4, Special observations shall contain all the elements normally included in a record observation from the station except that sea-level pressure, temperature, and dew point may be omitted.

2.4.3.2 Content of Aircraft Mishap Special Observations. Special observations taken because of an aircraft mishap shall contain all the elements normally included in a Record observation from the station except that sea-level pressure may be omitted.

Table 2-2. Guide to Contents of Surface Aviation Observations

Element of SAO Report / Type of Station:	AO1		AO1A		AO2		AO2A		Manual	
Type of Observation:	SA	SP	SA	SP	SA	SP	SA	SP	SA	SP
Station Identifier (9.6.1)	X	X	X	X	X	X	X	X	X	X
Type of Observation (9.6.2)	X	X	X	X	X	X	X	X	X	X
Time of Observation (9.6.3)	X	X	X	X	X	X	X	X	X	X
Type of Station (9.6.4)	X	X	X	X	X	X	X	X		
Sky Condition (9.6.5)										
≤ 12,000 feet	X	X	X	X	X	X	X	X	X	X
> 12,000 feet									X	X
Surface Visibility (9.6.6)	X	X	X	X	X	X	X	X	X	X
Weather & Obstructions to Vision (9.6.7)			D	D	X	X	X	X	X	X
Sea-level Pressure (9.6.8)	D	D	D	D	X	X	X	X	D	
Temperature (9.6.9)	X	X	X	X	X	X	X	X	X	S
Dew Point (9.6.10)	X	X	X	X	X	X	X	X	D	S/D
Wind Direction, Speed, and Character (9.6.11)	X	X	X	X	X	X	X	X	X	X
Altimeter Setting (9.6.12)	X	X	X	X	X	X	X	X	X	X
Remarks: (9.7)										
Runway Visual Range: (9.7.2)	D	D	D	D	D	D	D	D	D	D
Operationally Significant Remarks: (9.7.3)										
Weather and Obstructions to Vision (9.7.3.1)			D	D						
Surface-based Obscuring Phenomena (9.7.3.2)									X	X
Variable Sky Condition (9.7.3.3)									X	X
Tornadic Activity (9.7.3.4)			X	X			X	X	X	X
Thunderstorms (9.7.3.5)			X	X			X	X	X	X
Hail (9.7.3.6)			X	X			X	X	X	X
Intermittent Precipitation (9.7.3.7)									X	X
Sector Visibility (9.7.3.8)									X	X
Significant Cloud Types (9.7.3.9)									X	X
Virga (9.7.3.10)			X	X			X	X	X	X
Sky Condition & Visibility Not At Station (9.7.3.11)	D	D	D	D	D	D	D	D	D	D
Lightning (9.7.3.12)									X	X
Weather Not At Station (9.7.3.13)									X	X
Obscuring Phenomena Aloft (9.7.3.14)									X	X
Pressure Unsteady (9.7.3.15)									X	X
Barogram V (9.7.3.16)									D	
Volcanic Ash (9.7.3.17)			X	X			X	X	X	X

X - Indicates elements included at all stations.

D - Indicates elements included only at designated stations.

S - Indicates elements included in Special observations taken because of an Aircraft Mishap but not included in other Special observations.

Table 2-2 (Cont.). Guide to Contents of Surface Aviation Observations

Element of SAO Report / Type of Observation:	Type of Station: AO1		AO1A		AO2		AO2A		Manual	
	SA	SP	SA	SP	SA	SP	SA	SP	SA	SP
Special Notices: (9.7.4)										
No Specials Taken (9.7.4.1)									D	
Other Relevant Information (9.7.4.2)			D	D			D	D	D	D
First or Last Observations (9.7.4.3)									X	
Other Coded Remarks: (9.7.5)										
Synoptic Cloud Types (9.7.5.1)									D	
Depth of Snow on Ground (9.7.5.3)									D	
Additive Data: (9.7.6)										
Pressure Tendency (9.7.6.1)	D		D		X		X		D	
Precipitation Amount (9.7.6.2)	D		D		X		X		D	
24-Hour Precipitation (9.7.6.3)	D		D		X		X		D	
Maximum Temperature (9.7.6.4)	D		D		X		X		D	
Minimum Temperature (9.7.6.5)	D		D		X		X		D	
24-Hour Max/Min Temperature (9.7.6.6)	D		D		X		X		D	
Remarks Elaborating on Other Coded Data: (9.7.7)										
Variable Ceiling (9.7.7.1)	X	X	X	X	X	X	X	X	X	X
Tower/Surface Visibility (9.7.7.2)			D	D			D	D	D	D
Variable Surface Visibility (9.7.7.3)	X	X	X	X	X	X	X	X	X	X
Time of Beginning/Ending of Weather (9.7.7.4)	D		D		X		X		D	
Hourly Precipitation Amount (9.7.7.5)	D		D		X		X		D	
Wind Shift (9.7.7.6)	X	X	X	X	X	X	X	X	X	X
Variable Wind Direction (9.7.7.7)	X	X	X	X	X	X	X	X	X	X
Peak Wind (9.7.7.8)	X		X		X		X		X	
Pressure Rising/Falling Rapidly (9.7.7.9)	X	X	X	X	X	X	X	X	X	X

X - Indicates elements included at all stations.
D - Indicates elements included only at designated stations.

2.4.3.3 Single-element Special Observations. Agencies may authorize stations to disseminate single-element special observations. Such specials shall contain the station identifier, type of observation, time of observation, and type of station in addition to the element being reported. Throughout this Handbook, reference to the content of special observations excludes single-element special observations.

2.4.3.4 Criteria for Special Observations.

- CEILING. The ceiling (rounded off to reportable values) forms or dissipates below, decreases to less than, or if below, increases to equal or exceed:
  - 3,000 feet.
  - 1,500 feet.
  - 1,000 feet.
  - 500 feet.
  - 200 feet or the lowest standard instrument approach procedure minimum as published in the NOS *U.S. Terminal Procedures*.

- SKY CONDITION. A layer of clouds or obscuring phenomena aloft is present below 1,000 feet and no layer aloft was reported below 1,000 feet in the preceding SA, SP, or RS observation.

- VISIBILITY. Surface visibility as reported in the body of the report decreases to less than, or if below, increases to equal or exceed:
  - 3 miles.
  - 2 miles.
  - 1 1/2 miles.
  - 1 mile.
  - 1/2 mile or the lowest standard instrument approach procedure minimum as published in the NOS *U.S. Terminal Procedures*.

- TORNADO, FUNNEL CLOUD, OR WATERSPOUT.
  - is observed.
  - disappears from sight.
  - occurred within past hour according to outside sources, but was not observed or recorded at the station.

- THUNDERSTORM.
  - begins (a Special observation is not required to report the beginning of a new thunderstorm if one is currently reported in progress at the station).
  - increases in intensity (T becomes T+) at manual stations
  - ends.

- PRECIPITATION.
  - hail begins or ends.
  - freezing precipitation begins, ends, or changes intensity.
  - ice pellets begin, end, or change intensity at manual stations.

- ♦ WIND AND WIND SHIFT.
  - the average 2-minute wind speed suddenly increases to twice or more than twice the currently reported 2-minute wind speed and exceeds 25 knots.
  - wind direction changes by 45 degrees or more in less than 15 minutes and the wind speed is 10 knots or more.
- ♦ VOLCANIC ERUPTION.
  - Eruption first noted.
- ♦ AIRCRAFT MISHAP.
  - Upon notification of an Aircraft Mishap unless there has been an intervening Record or Record Special observation.
- ♦ MISCELLANEOUS. Any other meteorological situation designated by the responsible agency, or which, in the opinion of the observer, is critical.

2.4.4 Urgent Special Observations (USP). All observations containing information on tornadic activity or volcanic eruptions shall be transmitted immediately as a USP. If necessary to avoid delay in reporting the tornadic activity or volcanic eruptions, the USP may contain only those elements related to that event (see paragraph 2.4.3.3). Otherwise, the content shall be the same as a Special observation.

2.5 Observing Standards Applicable to All Stations.

2.5.1 Use of Certified Observers. All personnel performing an observation function (routine observations, augmentation, or backup) shall be certified in accordance with paragraph 10.2.1. Certification may be limited in accordance with their responsibilities.

2.5.2 Dropping Insignificant Figures. Except where otherwise designated in this Handbook, when computations require that a number be rounded, algebraic signs shall be disregarded and if the fractional part to be dropped is one-half or greater, the absolute value of the preceding digit shall be increased by one. If the fractional part to be dropped is less than one-half, the preceding digit shall be unchanged, e.g., 1.5 becomes 2, -1.5 becomes -2, 1.3 becomes 1, and 29.248 becomes 29.25.

2.5.3 Time Used in Observations.

2.5.3.1 Accuracy of Time in Observations. A procedure shall be established to assure that the accuracy of the timing device used to establish times in the observation program are within $\pm$ 1 minute of the U.S. Naval Observatory time.

2.5.3.2 Scheduled Time of Observation. The scheduled time of observation shall be the UTC time a Scheduled observation is required to be available for transmission.

2.5.3.3 Actual Time of Observation. The actual time of scheduled observations shall be the time the last element of the observation was observed. The actual time of Special observations shall, as specified by the responsible agency, be either:

- the time the criteria for a Special was met, or
- the time the last element of the observation was observed.

2.5.3.4 Time Disseminated in Observations. All times disseminated in observations shall be with reference to UTC and the 24-hour clock, e.g., 1:47 a.m. shall be referred to as 0147 and 1:47 p.m. as 1347. The times 0000 and 2359 shall indicate the beginning and ending of the day, respectively.

2.5.3.5 Time Logged in Observations. All times in logged observations shall be with reference to the 24-hour clock. The times that are disseminated as part of the observation shall be logged in UTC. However, at the discretion of the responsible agency, those times used to otherwise document the observation or other related observational data may be either Local Standard Time (LST) or UTC. The time standard selected shall be clearly indicated on all records and, if LST is used, the conversion to UTC shall also be indicated.

2.6 Observing Standards at Automated Stations.

Automated surface weather observing systems installed and operated as part of the SAO program shall be operated in accordance with the standards in this Handbook.

2.6.1 Sensor Siting Standards. All installations of sensors shall be in accordance with the latest *Federal Standard for Siting Meteorological Sensors at Airports* published by the OFCM. Presently installed sensors may be operated at their present location. However, if they must be relocated, the Federal standards shall be followed.

2.6.2 Algorithms Used by Automated Stations. Automated stations shall use algorithms that conform with the latest *Federal Standard Algorithms for Automated Weather Observing Systems Used for Aviation Purposes* published by the OFCM. These algorithms do not apply to previously authorized systems, which may continue to operate until replaced or modified.

2.6.3 Recency of Observed Elements at Automated Stations. Individual elements entered in an observation shall, as closely as possible, reflect conditions existing at the actual time of observation. For those elements that the human observer evaluates using spatial averaging techniques (e.g., sky cover and visibility) the automated station substitutes time averaging of sensor data. Therefore, in an automated observation, sky condition shall be an evaluation of sensor data gathered during the 30-minute period ending at the actual time of observation. All other elements evaluated shall be based on sensor data that is within 10 minutes or less of the actual time of observation.

2.6.4 Local Use Data at Automated Stations. Automated stations shall update weather elements each minute. These elements may be available for local display and voice dissemination.

2.6.5 Backup of Automated Stations. Agencies shall designate the stations where backup is required, define the level of backup, and establish backup procedures.

2.7 Recency of Observed Elements at Manual Stations.

Individual elements entered in an observation shall, as closely as possible, reflect conditions existing at the actual time of observation. Elements entered shall have been observed within 15 minutes of the actual time of observation. Gusts and squalls shall be reported if observed within 10 minutes of the actual time of observation. Record observations shall be made as close to the scheduled time of the observation as possible to meet filing deadlines but in no case shall these observations be started more than 15 minutes before the scheduled time.

2.8 Observing Standards at Augmented Stations.

2.8.1 Augmentation of Automated Observations. Data, which are beyond the capabilities of the automated system, may be added to the automated observation by an observer. This procedure is referred to as augmentation.

2.8.2 Augmentation Procedures. Agencies shall define the level of augmentation for each of their stations and the method by which the automated observation is augmented. The level of augmentation and the observing procedures used shall conform to the standards defined in Chapters 3 through 8 of this Handbook.

2.8.3 Validity of Augmented Data. Once an observer has augmented an observation, the observer shall be aware of the validity of the augmented observation and delete or change the observation, as necessary, to keep it valid.

2.8.4 Recency of Observed Elements at Augmented Stations. The data manually entered into the body of the observation at an augmented location shall have been evaluated within 15 minutes of the actual time of observation.

CHAPTER 3

SKY CONDITION

3.1 General.

Sky condition is a description of the appearance of the sky. Sky condition may be evaluated either automatically by instrument or manually. An automated sky condition is derived instrumentally by detecting the frequency and height of clouds passing over the sensor (ceilometer) over a period of 30 minutes. An algorithm processes the data from the sensor into data on layers, amounts and heights of clouds that are comparable to that determined manually. Sky condition is derived manually by visually estimating the amount of the sky covered and/or hidden by clouds or obscuring phenomena, and either visually or with the aid of instruments, determining their height. The manual observation of sky condition is performed over a very short period of time by mentally integrating the view of the sky from horizon to horizon.

3.2 Sky Condition Parameters.

Sky condition parameters are:

- **Sky cover**

  A measure of the amount of the sky that is either hidden by surface-based obscuring phenomena or covered but not necessarily hidden by clouds or obscuring phenomena aloft.

- **Summation layer amount**

  A categorization of the amount of sky cover at and below each reported layer of clouds or obscuring phenomena.

- **Layer height**

  The height of the bases of each reported layer of clouds or obscuring phenomena above the surface or field elevation; or the vertical visibility into a surface-based obscuring phenomena that is completely hiding the sky.

- **Ceiling**

  The height above the earth's surface (field elevation or ground elevation) of the lowest layer of clouds or obscuring phenomena aloft that is reported as broken or overcast, and is not classified "thin" or a surface-based obscuration not classified as "partial."

- **Layer opacity** (Manual Stations Only)

  An indication of the transparency of the summation sky cover of a layer of clouds or obscuring phenomenon aloft.

- **Type of clouds or obscuring phenomena** (Manual Stations Only)

  The variety of cloud or obscuring phenomena present.

3.3 Sky Condition Standards and Procedures Applicable to All Stations.

3.3.1 Sky Condition Observing Standards. Sky condition shall be evaluated at all stations with this capability. As a minimum, the evaluation shall be of the sky condition up to 12,000 feet above field level unless that range is restricted by clouds or obscuring phenomena.

3.3.1.1 Surface. For the purpose of reporting heights of cloud layers aloft, the surface shall be the assigned field elevation of the station. At stations where the field elevation has not been established, the surface shall be the ground elevation at the observation site.

3.3.1.2 Sky Cover. Sky cover shall be any clouds or obscuring phenomena detected from the observing location. It shall be evaluated with reference to the surface.

3.3.1.3 Stratification of Sky Cover. Sky cover shall be separated into layers with each layer containing clouds and/or obscuring phenomena aloft with bases at about the same height.

3.3.2 Determining Sky Cover Amounts.

3.3.2.1 Layer Amounts. The amount of sky cover for each layer shall be the tenths of sky cover attributable to the clouds or obscuring phenomena in the layer being evaluated.

3.3.2.2 Summation Layer Amount. The summation amount of sky cover for any given layer is the sum of the sky cover of the layer being evaluated, plus the sky cover of all lower layers. Portions of layers aloft detected through lower layers aloft shall not increase the summation amount of the higher layer. No layer can have a summation amount greater than 1.0 (10/10ths).

3.3.3 Determining Height of Sky Cover. If available, a ceilometer or ceiling light shall be used to measure the height of layers aloft or the vertical visibility into obscuring phenomena.

3.3.3.1 Height of Layers Aloft. The height of a layer shall be the average height of the bases of the sky cover in the layer above the surface. When the height of a ceiling layer increases and decreases rapidly by the amounts given in Table 3-1 during the period of evaluation, it shall be considered variable and the ascribed height shall be the average of all the values.

Table 3-1. Criteria for Variable Ceiling

Ceiling (feet)	Variation (feet)
≤ 1,000	≥200
>1,000 and ≤2,000	≥400
>2,000 and <3,000	≥500

3.3.3.2 Height of Surface-based Layers. Surface-based layers shall be those layers that are in contact with the surface. The height ascribed to surface-based layers shall be the vertical visibility, in feet, into the phenomenon. Layers of clouds or obscuring phenomena that are not in contact with the surface but are 50 feet or less above it, shall be reported as layers aloft and have a height of 0.

3.3.4 Determining Ceiling. The lowest layer that is reported as obscured, broken, or overcast and is not reported as thin or partial (see paragraph 3.5.1.6) shall be the ceiling layer.

3.3.5 Sky Condition Reporting Standards

3.3.5.1 Reporting Frequency for Sky Condition. Sky condition shall be reported in all Record, Record Special, and Special observations.

3.3.5.2 Reporting Layer Amount. The amount of sky cover reported for each layer shall be based on the summation layer amount for that layer. The amount shall be reported using the reportable values given in Table 3-2.

3.3.5.3 Units of Measure for Heights. Heights of sky cover shall be evaluated in feet above the surface.

3.3.5.4 Reportable Values for Sky Cover Height. The reportable values of sky cover are hundreds of feet, in the increments given in Table 3-3.

3.3.5.5 Reporting Layer Heights. Heights of layers shall be reported in hundreds of feet, rounded to the nearest reportable increment. When a value falls halfway between two reportable increments, the lower value shall be reported.

Table 3-2. Reportable Values for Sky Cover Amount

Reportable Value	Meaning	Summation Amount of Layer	
		Military	Civilian
-X[1]	Partial Obscuration	<1.0	<1.0
X	Obscured Sky	1.0	1.0
CLR[2]	Clear	0	0 - <0.1
SCT[3]	Scattered	>0 - 0.5	0.1 - 0.5
BKN[3]	Broken	0.6 - <1.0	0.6 - 0.9
OVC[3]	Overcast	1.0	>0.9 - 1.0

1. Manual observations only.
2. For automated and augmented observations, when no clouds are detected within the range of the sensor, "CLR BLO xxx" shall be reported, where xxx is within range of the ceilometer.
3. For manual observations, prefix these values with a "-" if the layer is thin (see paragraph 3.5.1.6).

Table 3-3. Increments of Reportable Values of Sky Cover Height

Range of Height Values (feet)	Reportable Increment (feet)
≤5,000	To nearest 100
>5,000 but ≤10,000	To nearest 500
>10,000	To nearest 1,000

3.3.5.6 Reporting Ceiling. The ceiling layer shall be indicated in the report by prefixing the reported height with a ceiling designator. See the reporting procedure for automated stations (paragraph 3.4.3.4) and manual stations (paragraph 3.5.2.5) for details on selecting the ceiling designator.

3.3.5.7 Reporting Variable Ceiling. When the height of the ceiling layer is variable, and the reported ceiling is below 3,000 feet, a "V" shall be suffixed to the reported height to indicate that it is variable (see paragraph 9.6.5) and a remark shall be included in the observation giving the range of variability (see paragraph 9.7.7.1).

3.3.6 Sky Condition Performance Standards

3.3.6.1 Range of Sky Condition. The method used to evaluate sky condition (amount and height), manually or instrumentally, shall have the capability to do so from the surface to at least 12,000 feet.

3.3.6.2 Accuracy of Sky Condition. The method used to evaluate sky condition shall be capable of producing heights within plus or minus three reportable values and amounts within plus or minus one reportable value.

3.4 Sky Condition at Automated Stations

3.4.1 Sky Condition Algorithms at Automated Stations. In accordance with the *Federal Standard Algorithms for Automated Weather Observing Systems Used for Aviation Purposes*, the sky condition algorithm processes the sensor output to determine the sky condition. The sky condition data is then examined to determine if variable heights exist. Where the automated system has multiple sky condition sensors, the data from the additional sensors are examined to determine if their values should be reported in Remarks.

3.4.2 Observing Standards at Automated Stations.

3.4.2.1 Sky Cover at Automated Stations. All sensor output of clouds or obscuring phenomena aloft shall be considered to be opaque sky cover.

3.4.2.2 Determining the Height of Sky Cover at Automated Stations. A ceilometer shall be used to measure the height of layers aloft or the vertical visibility into obscuring phenomena.

3.4.2.3 Determining Height of Surface-based Layers at Automated Stations. The height ascribed to surface-based layers shall be the vertical visibility, in feet, into the phenomenon.

3.4.2.4 Determining Non-Uniform Sky Condition at Automated Stations. At automated stations that have multiple ceilometers, the data from the secondary sensors shall be examined and compared with the data from the primary sensor to determine if remarks are required to report non-uniform conditions.

3.4.3 Sky Condition Reporting Procedures at Automated Stations.

3.4.3.1 Number of Layers Reported at Automated Stations. Automated stations shall report no more than three layers of clouds or obscuring phenomena. The layer reported shall be selected in accordance with Table 3-4.

3.4.3.2 Reporting Layer Amounts at Automated Stations. At automated stations, algorithms produce reportable layer amounts which are the functional equivalent of the reportable values in Table 3-2.

3.4.3.3 Reporting Layer Heights at Automated Stations. The standard procedures described in paragraph 3.3.5.5 shall be used to report heights at automated stations.

Table 3-4. Priority for Reporting Layers

Priority	Layer Description
1	lowest scattered layer.
2	lowest broken layer.
3	overcast layer.
4	second lowest scattered layer.
5	second lowest broken layer.
6	highest broken layer.
7	highest scattered layer.

3.4.3.4 Reporting Ceiling at Automated Stations. The ceiling layer shall be indicated by prefixing the layer height with the appropriate designator letter M or W as defined below:

- **Measured (M) Ceiling**. Ceiling heights ascribed to layers aloft shall be classified as "measured" when determined from a ceilometer operating within its operational range.

- **Indefinite (W) Ceiling**. Ceiling heights shall be classified as "indefinite" when the value being reported is the vertical visibility into a surface-based obscuration.

3.4.3.5 Reporting Variable Ceiling at Automated Stations. The standard reporting procedure defined in paragraph 3.3.5.7 shall be used to report variable ceilings at automated stations.

3.4.3.6 Reporting Non-Uniform Sky Conditions at Automated Stations. If, because of non-uniform conditions, a sky condition remark is required, the conditions shall be described in Remarks. The actual content and format of the remark shall be defined by the Federal algorithms referred to in paragraph 3.4.1.

3.5 Sky Condition at Manual Stations.

3.5.1 Observing Standards at Manual Stations. The observation of sky condition at manual stations shall be an evaluation of the sky visible from the point of observation. It shall include an evaluation of the opacity of each cloud layer observed.

3.5.1.1 Range of Sky Condition Reports at Manual Stations. Observers at manual stations shall evaluate all clouds and obscuring phenomena visible; i.e., the 12,000 foot restriction shall not apply.

3.5.1.2 Evaluation of Interconnected Layers at Manual Stations. Clouds formed by the horizontal extension of swelling cumulus or cumulonimbus, that are attached to a parent cloud, shall be regarded as a separate layer only if their bases appear horizontal and at a different level from the parent cloud. Otherwise, the entire cloud system shall be regarded as a single layer at a height corresponding to that of the base of the parent cloud.

3.5.1.3 Determining Amount of Sky Cover at Manual Stations. The summation amount of sky covered at and below each layer shall be determined. Also, the amount of opaque sky cover at and below the layer under evaluation shall be determined. Clouds or obscuring phenomena aloft that shield the sky, higher clouds or obscuring phenomena, or the moon or stars from the observer's view shall be considered opaque sky cover. Surface-based obscuring phenomena shall not be considered sky cover if the sky, higher clouds or obscuring phenomena aloft, or the moon or stars are visible through it. Table 3-5 can be used to estimate the sky cover amounts of advancing, receding or continuously surrounding layers.

Table 3-5. Sky Cover Evaluation

Angle of Advancing or Receding Layer Edge	Tenths of Sky Cover	Angular Elevation of Layer Surrounding Station
0° to 25°	0	0° to 2°
26° to 45°	1	3° to 8°
46° to 59°	2	9° to 14°
60° to 72°	3	15° to 20°
73° to 84°	4	21° to 26°
85° to 95°	5	27° to 33°
96° to 107°	6	34° to 40°
108° to 119°	7	41° to 48°
120° to 134°	8	49° to 58°
135° to 154°	9	59° to 71°
155° to 180°	10	72° to 90°

3.5.1.4 Determining Amount of Partial Obscuration at Manual Stations. If a portion (but not all) of the sky (including higher clouds or obscuring phenomena, the moon, or stars) is not visible because of surface-based obscuring phenomena, determine the tenths of sky that are not visible. That portion is the amount of the partial obscuration.

3.5.1.5 Determining Variable Amounts of Sky Cover at Manual Stations. The sky cover amount shall be considered variable if it varies by one or more reportable values during the period it is being evaluated.

3.5.1.6 Determining Thin Layers at Manual Stations. A layer shall be considered to be thin if the ratio of transparent sky cover to total sky cover (opaque plus transparent) is one-half or more.

3.5.1.7 Determining Vertical Visibility at Manual Stations. Vertical visibility shall be either:

- The distance that an observer can see vertically upward into surface-based obscuring phenomena or

- The height corresponding to the top of a ceiling light projector beam, or the height at which a balloon completely disappears during the presence of surface-based obscuring phenomena.

3.5.1.8 Determining Height of Sky Cover at Manual Stations. If available, a ceilometer or ceiling light, or known heights of unobscured portions of abrupt, isolated objects within 1 1/2 nautical miles of a runway shall be used to measure the height of layers aloft or the vertical visibility into obscuring phenomena. Otherwise an alternative method shall be used to estimate the heights. The height may be estimated by using a ceiling balloon, pilot report, other agency guidelines, or experience.

3.5.1.9 Determining Variable Ceiling at Manual Stations. The standard procedures described in paragraph 3.3.3.1 shall be used at manual stations to determine variable ceilings.

3.5.1.10 Determining Significant Clouds and Cloud Types at Manual Stations. The observer shall be alert for the occurrence of cumulonimbus, towering cumulus, altocumulus castellanus, standing lenticular, or rotor clouds and report them whenever they occur. In addition, observers at designated manual stations shall identify cloud types in accordance with the WMO *International Cloud Atlas*, Volumes I and II, or the WMO *Abridged International Cloud Atlas* for inclusion in 3- and 6-hourly observations.

3.5.1.11 Determining Non-Uniform Sky Condition at Manual Stations. Observers at manual stations shall be alert to variations in sky condition that are not reflected in the sky cover reported in the body of the SAO.

3.5.2 Sky Condition Reporting Procedures at Manual Stations.

3.5.2.1 Number of Layers Reported at Manual Stations. All layers visible from the station shall be reported in sky cover reports from manual stations.

3.5.2.2 Reporting Layer Amount at Manual Stations. Table 3-2 shall be used to determine the reported value for each layer visible. The report shall be based on the tenths of sky covered by each layer in combination with any lower layers.

3.5.2.3 Reporting Thin Layers at Manual Stations. Thin layers shall be indicated in the SAO by prefixing the reported sky cover amount with a "–".

3.5.2.4 Reporting Layer Heights at Manual Stations. The standard procedures described in paragraph 3.3.5.5 shall be used to report heights at manual stations.

3.5.2.5 Reporting Ceiling at Manual Stations. The ceiling layer shall be indicated in the report by prefixing the reported layer height with an appropriate designator letter M, E, or W defined below:

- **Measured (M) Ceiling**. Ceiling heights ascribed to layers aloft shall be classified as "measured" when they are determined from:
  - a ceilometer operating within its operational range,
  - the known height of unobscured portions of abrupt, isolated objects within 1 1/2 miles of a runway,
  - a ceiling light when the heights measured are less than 10 times the distance from the projector to the detector,
- **Estimated (E) Ceiling**. Ceiling heights ascribed to layers aloft shall be classified as "estimated" when determined by any method other than those described under "measured" above.
- **Indefinite (W) Ceiling**. Ceiling heights shall be classified as "indefinite" when the value being reported is the vertical visibility into a surface-based obscuring phenomena that completely hides the sky.

3.5.2.6 Reporting Amount of Partial Obscurations at Manual Stations. The standard procedures defined in paragraph 9.7.3.2 shall be used at manual stations to report the tenths of sky obscured by a partial obscuration.

3.5.2.7 Reporting Variable Ceiling at Manual Stations. The standard procedures defined in paragraph 3.3.5.7 shall be used at manual stations.

3.5.2.8 Reporting Variable Layer Amounts at Manual Stations. When a layer amount varies between reportable values during the time the amount is being evaluated, a variable sky condition remark shall be included in the observation. The format of the remark is given in paragraph 9.7.3.3.

3.5.2.9 Reporting Significant Clouds and Synoptic Cloud Types at Manual Stations. Cumulonimbus, towering cumulus, altocumulus castellanus, standing lenticular or rotor clouds shall be reported by entering a remark in Record, Record Special, and Special observations. The remark shall contain the identification of the cloud, the direction and distance from the station (insofar as known), and, except for standing lenticular or rotor clouds, the direction of movement. In addition, designated stations shall report the types of low, middle, and high clouds present in 3- and 6-hourly observations as additive data. See paragraph 9.7.5.1 for detailed instructions on coding these remarks.

3.5.2.10 Reporting Non-uniform Sky Condition at Manual Stations. When non-uniform sky conditions are observed, the observer shall describe the condition in Remarks. Unless a height is available from a reliable source, the height shall be described in relation to the heights reported in the body of the report. For example, CIG LWR N would indicate that ceilings are significantly lower to the north.

3.6 Summary of Sky Condition Observing and Reporting Standards.

Table 3-6 summarizes the sky condition observing and reporting at each category of station.

Table 3-6. Summary of Sky Condition Observing and Reporting Standards

Data	Type of Station	
	Automated	**Manual**
Sky Cover (General)	Represents a 30-minute average of sensor outputs.	Visual evaluation of sky condition within 10 minutes of the observation time.
	100' to 12,000 feet.	All layers observed.
Layer amount/ceiling	Assumes all clouds/obscuring phenomena detected are opaque.	Discriminates between thin and opaque sky cover.
	Layers are not reported as thin. Obscurations are not reported as partial.	Thin layers and partial obscurations shall be reported.
	Ceiling values based on all clouds detected.	Ceiling based on opaque clouds, only.
	Ceiling reported as either measured (M) or indefinite (W).	Ceiling reported as measured (M), estimated (E), or indefinite (W).
Number of layers	Maximum of three.	All layers observed.
Variable sky cover amounts	Not evaluated.	Evaluated.
Variable ceiling height	Evaluated at all stations.	
Non-Uniform Sky Condition	Evaluated at stations with multiple sensors.	Visual evaluation.
Cloud Types	Not evaluated.	Significant clouds at all stations and synoptic cloud types at designated stations.

CHAPTER 4

VISIBILITY

4.1 General.

In the context of FMH No.1, visibility is a measure of the opacity of the atmosphere and is expressed in terms of the horizontal distance at which a person should be able to see and identify specified objects. It may be determined automatically by instruments or manually. An automated instrumentally-derived visibility value is a sensor value converted to an appropriate visibility value using standard algorithms. The automated visibility is considered to be representative of the visibility in the general vicinity of the airport runway complex. It can be different from the visibility determined manually by an observer using the "prevailing visibility" concept. In this chapter, the term "prevailing visibility" refers to that parameter determined manually as well as that parameter determined instrumentally.

4.2 Scope.

This chapter describes the standards and procedures for determining and reporting visibility. It discusses how these values are determined for automated and manual observations.

4.3 Visibility Parameters.

The visibility parameters are:

- **Prevailing visibility**

  The visibility that is considered representative of visibility conditions at the station.

- **Sector visibility** (manual stations)

  The visibility in a specified direction that represents at least a 45 degree arc of the horizon circle.

- **Surface visibility**

  The prevailing visibility determined from the usual point of observation.

- **Tower visibility** (designated locations)

  The prevailing visibility determined from the airport traffic control tower (ATCT) at locations that also report the surface visibility.

4.4 Visibility Reporting Standards.

4.4.1 Unit of Measure. Visibility shall be reported in statute miles.

4.4.2 Reporting Surface Visibility. Surface visibility shall be reported in all weather observations, except single-element specials.

4.4.3 Reporting Variable Surface Visibility. Variable visibility shall be reported in Remarks of all weather observations if the surface visibility is less than 3 miles and rapidly increases and decreases during the time of observation by 1/2 mile or more. A suffix "V" shall follow the prevailing visibility to indicate that the visibility is variable and a variable visibility remark shall be included in the observation. The format for the remark is given in paragraph 9.7.7.3.

4.4.4 Reporting Tower Visibility. Tower visibility shall be reported, in accordance with agency procedures, when it is less than 4 miles and less than surface visibility. If the surface visibility is less than 4 miles and the tower visibility is greater than the surface visibility, tower visibility shall be in the Remarks.

4.5 Visibility at Automated Stations.

4.5.1 Visibility Sensor Range. Visibility sensors shall evaluate visibility from less than one-quarter statute mile (< 1/4) to at least 10 statute miles.

4.5.2 Visibility Sensor Accuracy. Visibility sensors shall meet the accuracies given in Table 4-1.

Table 4-1. Accuracy of Visibility Sensors

Visibility from Standard Visibility Sensor	Percentage of Data Within or Exceeding Given Range		
	At least 80% Within	No more than 18% Exceed	No more than 2% Exceed
0 through 1 1/4	± 1/4	± 1/2	± 1
1 1/2 through 1 3/4	+ 1/4, − 1/2	+ 1/2, − 3/4	± 1
2 through 2 1/2	± 1/2	± 1	± 1
3 through 3 1/2	+ 1/2, − 1	± 1	± 1
4 through 10	± 1 RV*	± 2 RV*	± 2 RV*
*RV = Reportable value, all other values in miles.			

4.5.3 Visibility Algorithms. In accordance with the *Federal Standard Algorithms for Automated Weather Observing Systems Used for Aviation Purposes*, the visibility algorithm calculates an average visibility which is the sensor equivalent of prevailing visibility. The visibility data during the averaging period are examined to determine if variable visibility shall be reported. Where the automated system has multiple functioning visibility sensors, the data from the additional sensors are examined to determine if their visibility values meet criteria for generating a visibility remark.

4.5.4 Reportable Visibility Values at Automated Stations. The minimum reportable values for visibility are: < 1/4, 1/4, 1/2, 3/4, 1, 1 1/4, 1 1/2, 1 3/4, 2, 2 1/2, 3, 3 1/2, 4, 5, 7, and 10 statute miles. If the actual visibility falls halfway between two reportable values, the lower value will be reported.

4.6 Visibility at Manual Stations.

4.6.1 Manual Visibility Standards. Visibility may be determined at either the surface, the tower level, or both. If visibility observations are made from just one level (e.g., the airport traffic control tower), that level shall be considered the "usual point of observation" and that visibility shall be reported as surface visibility. If visibility observations are made from both levels, the visibility at the tower level shall be reported as tower visibility.

4.6.2 Observing Site at Manual Stations. Where the observer's view of the horizon is obstructed, the observer shall move to as many locations as necessary and practicable within the time allotted for the observation to view as much of the horizon as possible. In this respect, natural obstructions, such as trees, hills, etc., are not obstructions to the horizon. These natural obstructions define the horizon.

4.6.3 Observing Aids at Manual Stations. Agencies shall establish procedures to ensure that insofar as possible, dark or nearly dark objects viewed against the horizon sky shall be used during the day, and unfocused lights of moderate intensity (about 25 candela) shall be used during the night as reference points for determining visibility. In addition, visibility sensors may be used to assist the observer in the evaluation.

4.6.4 Adaptation to Ambient Light Conditions at Manual Stations. Agencies shall establish procedures to ensure that observer's eyes shall be accustomed to the ambient lighting conditions before visibility observations are taken.

4.6.5 Determining Visibility at Manual Stations. Visibility shall be evaluated as frequently as practicable. All available visibility reference points shall be used. The greatest distances that can be seen in all directions around the horizon circle shall be determined. When the visibility is greater than the distance to the farthest reference point, the greatest distance you can see in each direction shall be estimated. This estimate shall be based on the appearance of the most distant visible reference points. If they are visible with sharp outlines and little blurring of color, the visibility is much greater than the distance to them. If they can barely be seen and identified, the visibility is about the same as the distance to them.

4.6.5.1 Determining Prevailing Visibility. After visibilities have been determined around the entire horizon circle, they shall be resolved into a single value for reporting purposes. To do this, the greatest distance that can be seen throughout at least half the horizon circle, not necessarily continuous shall be used. If the visibility is varying rapidly during the time of the observation, the average of all observed values around the horizon circle shall be used for reporting purposes.

4.6.5.2 Determining Variable Visibility. If the prevailing visibility rapidly increases and decreases by a 1/2 statute mile or more during the time of the observation, and the average prevailing visibility is less than 3 miles, the visibility is considered to be variable and the minimum and maximum visibility values observed shall be reported in Remarks. The format for the remark is given in paragraph 9.7.7.3.

4.6.5.3 Determining Sector Visibility. When the visibility is not uniform in all directions, the horizon circle shall be divided into arcs that have uniform visibility and represent at least one eighth of the horizon circle (45 degrees). The visibility that is evaluated in each sector is sector visibility.

4.6.6 Reporting Visibility at Manual Stations.

4.6.6.1 Reportable Visibility Values at Manual Stations. The reportable values for visibility at manual stations are listed in Table 4-2. If the actual visibility falls halfway between two reportable values, the lower value shall be reported.

4.6.6.2 Reporting Sector Visibility at Manual Stations. Sector visibility shall be reported in Remarks of weather observations when it differs from the surface visibility by one or more reportable values and either the surface or sector visibility is less than 3 miles. The format for the remark is given in paragraph 9.7.3.8.

4.7 Tower Visibility.

At designated locations, ATCT personnel shall determine tower visibility in accordance with paragraph 4.6. The tower visibility shall be reported in accordance with paragraph 4.4.4.

4.8 Summary of Visibility Observing and Reporting Standards.

Table 4-2 summarizes the applicability of visibility standards and procedures to each category of station.

Table 4-2. Summary of Visibility Observing and Reporting Standards and Procedures

Visibility	Type of Station	
	Automated	**Manual**
Surface	Represents a 10-minute average of sensor outputs.	Visual evaluation of visibility around the horizon.
Variable	Reported when the prevailing visibility varies by 1/2 mile or more and the average visibility is less than 3 miles.	
Tower	Not reported.	Reported at all stations.
Sector	Not reported.	Reported at all stations.
Reportable values	< 1/4, 1/4, 1/2, 3/4, 1, 1 1/4, 1 1/2, 1 3/4, 2, 2 1/2, 3, 3 1/2, 4, 5, 7, 10 statute miles.	0, 1/16, 1/8, 3/16, 1/4, 5/16, 3/8, 1/2, 5/8, 3/4, 7/8, 1, 1 1/8, 1 1/4, 1 3/8, 1 1/2, 1 5/8, 1 3/4, 1 7/8, 2, 2 1/4, 2 1/2, 2 3/4, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 20, 25, 30, 40 statute miles, etc.

CHAPTER 5

WEATHER AND OBSTRUCTIONS TO VISION

5.1 General.

This chapter contains instructions on identifying and reporting weather and obstructions to vision. For the purpose of this Handbook, weather is a category of atmospheric phenomena that includes tornadoes, funnel clouds, waterspouts, thunderstorms, and precipitation. Obstructions to vision are those phenomena that reduce visibility but are not a form of precipitation.

5.2 Types of Weather and Obstructions to Vision.

The types of weather and obstructions to vision reported in SAOs vary according to the type of station, and in the case of augmented stations, to the level of augmentation defined by the responsible agency. Table 5-1 indicates, in general, the types of weather and obstructions to vision reported by the various types of stations. Definitions of these phenomena are given in the following paragraphs:

5.2.1 Tornadic Activity.

a. **Tornado.** A violent, rotating column of air touching the ground.

b. **Funnel cloud.** A violent, rotating column of air which does not touch the ground.

c. **Waterspout.** A violent, rotating column of air that forms over a body of water, and touches the water surface.

5.2.2 Thunderstorms.

a. **Severe thunderstorm.** (manual) A storm produced by a cumulonimbus cloud that is accompanied by lightning and thunder and by wind gusts of 50 knots or higher, and/or hail 3/4 inch or greater diameter.

b. **Thunderstorm.** (automated) A storm detected by the occurrence of cloud to ground lightning.

Thunderstorm. (augmented and manual) A storm produced by a cumulonimbus cloud that is accompanied by lightning and thunder, and does not meet the criteria for a severe thunderstorm.

5.2.3 Precipitation. Any of the forms of water particles, whether liquid or solid, that fall from the atmosphere and reach the ground. The types of precipitation reported in SAOs are:

a. **Unknown Precipitation.** (automated) An indication of light precipitation occurrence which is reported when the precipitation discriminator detects but cannot recognize the type of precipitation.

b. **Liquid Precipitation.** Any form of precipitation that does not fall as frozen precipitation and does not freeze upon impact. Types of liquid precipitation reported in SAOs are:

1. **Drizzle.** (manual) Fairly uniform precipitation composed exclusively of fine drops (diameter less than 0.02 inch or 0.5 mm) very close together.

2. **Rain.** (manual) Precipitation, either in the form of drops larger than 0.02 inch (0.5 mm), or smaller drops which, in contrast to drizzle, are widely separated.

   Rain. (automated) Precipitation that remains in the liquid state upon impact with the ground, or other exposed objects.

   [Note: Current sensors may report ice pellets as rain.]

c. **Freezing Precipitation**. Any form of precipitation that freezes upon impact and forms a glaze on the ground or exposed objects. Types of freezing precipitation reported in SAOs are:

1. **Freezing drizzle.** (manual) Drizzle which freezes upon impact with the ground, or other exposed objects.

2. **Freezing rain.** Rain that freezes upon impact with the ground, or other exposed objects.

d. **Frozen precipitation**. Any form of precipitation that reaches the ground in solid form (snow, ice pellets, hail). Types of frozen precipitation reported in SAOs are:

1. **Snow.** (automated) Any form of frozen precipitation other than hail.

   Snow. (manual) Precipitation of snow crystals, mostly branched in the form of six-pointed stars.

2. **Snow pellets.** (manual) Precipitation of white, opaque grains of ice. The grains are round or sometimes conical. Diameters range from about 0.08 to 0.2 inch (2 to 5 mm).

3. **Snow grains.** (manual) Precipitation of very small, white, opaque grains of ice; the solid equivalent of drizzle.

4. **Hail.** (augmented and manual) Precipitation in the form of small balls or other pieces of ice falling separately or frozen together in irregular lumps.

5. **Ice pellets.** (manual) Precipitation of transparent or translucent pellets of ice, which are round or irregular, rarely conical, and which have a diameter of 0.2 inch (5 mm), or less. There are two main types:

   - Hard grains of ice consisting of frozen raindrops, or largely melted and refrozen snowflakes.

   - Pellets of snow encased in a thin layer of ice which have formed from the freezing, either of droplets intercepted by the pellets, or of water resulting from the partial melting of the pellets.

6. **Ice crystals.** (manual) A fall of unbranched (snow crystals are branched) ice crystals in the form of needles, columns, or plates.

5.2.4 Obstructions to Vision. Any phenomenon in the atmosphere, other than precipitation, that reduces the horizontal visibility. Those reported in SAOs when the horizontal visibility is reduced to less than 7 miles are:

a. **Blowing dust.** (manual) Dust raised by the wind to a height sufficient to restrict horizontal visibility.

b. **Blowing sand.** (manual) Sand particles raised by the wind to a height sufficient to reduce horizontal visibility.

c. **Blowing snow.** (manual) Snow particles raised by the wind to a height sufficient to reduce horizontal visibility.

d. **Blowing spray.** (manual) Water droplets torn by the wind from a body of water, generally from the crests of waves, and carried up into the air in such quantities that it reduces the horizontal visibility.

e. **Dust.** (manual) Fine particles of earth or other matter raised or suspended in the air by the wind that may have occurred at or far away from the station.

f. **Fog.** (automated) A visible aggregate of minute water particles (droplets) which are based at the Earth's surface and reduce horizontal visibility.

   Fog. (manual) A visible aggregate of minute water particles (droplets) which are based at the Earth's surface, with a depth of greater than approximately 20 feet, that reduces horizontal and vertical visibility.

g. **Ground fog**. (manual) Fog that has little vertical extent (normally less than 20 feet), and reduces visibility horizontally, but to a lesser extent vertically. The stars may often be seen by night and the sun by day.

h. **Haze.** (automated) Fine particles of dust, salt, combustion products, or pollution products that are suspended in the atmosphere diminishing visibility (distinguished from fog by its dryness).

Haze. (manual) A suspension in the air of extremely small, dry particles invisible to the naked eye and sufficiently numerous to give the air an opalescent appearance.

i. **Ice fog.** (manual) A suspension of numerous, minute ice crystals in the air, based at the Earth's surface, which reduces horizontal visibility.

j. **Smoke**. (manual) A suspension in the air of small particles produced by combustion. A transition to haze may occur when smoke particles have traveled great distances (25 to 100 miles or more) and when the larger particles have settled out and the remaining particles have become widely scattered through the atmosphere.

k. **Volcanic ash (dust)**. (augmented and manual) Fine particles of rock powder that are blown out from a volcano and that may remain suspended in the atmosphere for long periods.

5.3 Weather and Obstructions to Vision Standards and Procedures Applicable to All Stations.

Weather and obstructions to vision may be evaluated instrumentally, manually, or through a combination of instrumental and manual methods.

5.3.1 Identifying Weather and Obstructions to Vision. Types of weather and obstructions to vision shall be identified in accordance with the definitions given in paragraph 5.2.

5.3.2 Reporting Weather and Obstructions to Vision. Weather may be reported in the body of the SAO only when it is occurring at the station at the time the observation is prepared for dissemination. Obstructions to vision may be reported in the body of the SAO only when occurring at the station at the time the observation is prepared for dissemination and the surface visibility is less than 7 miles. Other data pertaining to weather and obstructions to vision may be reported in Remarks of the SAO. The notations in Table 5-1 shall be used to report weather and obstructions to vision in the SAO. The formats for the various reports are given in Chapter 9.

Table 5-1 Weather and Obstructions to Vision Reported in SAOs

Type of Weather	Reporting Notation	Type of Station				
		AO1	AO1A	AO2	AO2A	Manual
TORNADO	TORNADO		X		X	X
FUNNEL CLOUD	FUNNEL CLOUD		X		X	X
WATERSPOUT	WATERSPOUT		X		X	X
Severe Thunderstorm	T+					X
Thunderstorm	T		X	X	X	X
Precipitation	P–			X		
Rain	R		X	X	X	X
Drizzle	L					X
Freezing Rain	ZR		X	D	D	X
Freezing Drizzle	ZL					X
Hail	A		X		X	X
Ice Crystals	IC					X
Ice Pellets	IP					X
Snow	S		X	X	X	X
Snow Pellets	SP					X
Snow Grains	SG					X

X = Element reported by all stations.
D = Element reported at designated stations only.

Table 5-1 (Cont.) Weather and Obstructions to Vision Reported in SAOs

Type of Obstruction to Vision	Reporting Notation	Type of Station				
		A01	A01A	A02	A02A	Manual
Dust	D					X
Fog	F		X	X	X	X
Ground Fog	GF					X
Ice Fog	IF					X
Haze	H		X	X	X	X
Smoke	K					X
Blowing Dust	BD					X
Blowing Sand	BN					X
Blowing Snow	BS					X
Blowing Spray	BY					X
Volcanic Ash	VOLCANIC ASH		X		X	X

X = Element reported by all stations.

5.3.3 Order for Reporting Multiple Types of Weather and Obstructions to Vision. When more than one type of weather and/or obstruction to vision is reported at the same time, they shall be reported in the following order:

TORNADO, FUNNEL CLOUD, or WATERSPOUT,
Thunderstorms,
Liquid precipitation in order of decreasing intensity,
Freezing precipitation in order of decreasing intensity,
Frozen precipitation in order of decreasing intensity, and
Obstructions to vision in order of decreasing predominance.

5.3.4 Observing Standards for Precipitation.

5.3.4.1 Determining the Intensity of Precipitation. No intensity shall ever be given to hail or ice crystals. Unknown precipitation (P) shall always be reported as light (P−). Otherwise, the intensity of precipitation shall be identified as light, moderate, or heavy in accordance with the one of the following:

- **Intensity of Rain, Freezing Rain, or Ice Pellets**

  The intensity of rain, freezing rain, and ice pellets shall be based on the criteria given in Table 5-2, Table 5-3, and Table 5-4.

- **Intensity of Snow (all varieties) and Drizzle**

  The intensity of snow and drizzle shall be based on the reported surface visibility in accordance with Table 5-5 when occurring alone.

Table 5-2. Intensity of Rain, Freezing Rain, or Ice Pellets Based on Rate-of-Fall

Intensity	Criteria
Light	Up to 0.10 inch per hour; maximum 0.01 inch in 6 minutes.
Moderate	0.11 inch to 0.30 inch per hour; more than 0.01 inch to 0.03 inch in 6 minutes.
Heavy	More than 0.30 inch per hour; more than 0.03 inch in 6 minutes.

Table 5-3. Estimating Intensity of Rain or Freezing Rain

Intensity	Criteria
Light	From scattered drops that, regardless of duration, do not completely wet an exposed surface up to a condition where individual drops are easily seen.
Moderate	Individual drops are not clearly identifiable; spray is observable just above pavements and other hard surfaces.
Heavy	Rain seemingly falls in sheets; individual drops are not identifiable; heavy spray to height of several inches is observed over hard surfaces.

Table 5-4. Estimating Intensity of Ice Pellets

Intensity	Criteria
Light	Scattered pellets that do not completely cover an exposed surface regardless of duration. Visibility is not affected.
Moderate	Slow accumulation on ground. Visibility reduced by ice pellets to less than 7 miles.
Heavy	Rapid accumulation on ground. Visibility reduced by ice pellets to less than 3 miles.

Table 5-5. Intensity of Snow or Drizzle Based on Visibility

Intensity	Criteria
Light	Visibility > 1/2 mile.
Moderate	Visibility > 1/4 mile but ≤ 1/2 mile.
Heavy	Visibility ≤ 1/4 mile.

5.3.4.2 Determining the Time of Precipitation Occurrence. Designated stations shall determine the time to the nearest minute that precipitation begins or ends.

5.3.4.3 Determining the Amount of Precipitation. At designated stations, the amount of liquid precipitation shall be evaluated as the depth of precipitation that accumulates in an exposed vessel during the time period being evaluated. The amount of freezing or frozen precipitation shall be the liquid equivalent (water content) of the solid precipitation accumulated during the appropriate time period.

5.3.4.4 Units of Measure for Precipitation. Precipitation measurements shall be in inches, tenths of inches, or hundredths of inches depending on the precipitation being measured (see Table 5-6).

Table 5-6. Units of Measure for Precipitation

Type of Measurement	Unit of Measure
Liquid Precipitation	0.01 inch
Liquid Equivalent of Solid Precipitation	0.01 inch
Solid Precipitation	0.1 inch
Snow Depth	1 inch

5.3.4.5 Range and Accuracy of Precipitation Sensors. Table 5-7 lists the range and accuracy requirements for precipitation sensors.

Table 5-7. Range and Accuracy of Precipitation Sensors

Type of Sensor	Range	Accuracy
Liquid Precipitation	0 - 10 inches	±0.02 inch or 4% of the accumulation, whichever is greater.
Liquid Equivalent of Frozen Precipitation	0 - maximum amount anticipated	±0.04 inch or 4% of the accumulation whichever is greater.
Snow Depth	0 - maximum depth anticipated	±0.5 inch from 0 - 5 inches. ±1.0 inch above 5 inches.

5.3.4.6 Reporting Beginning and Ending Times of Weather. At designated stations, the time precipitation begins or ends shall be reported in Remarks of the next Record observation after the event. Times for separate periods shall be reported only if the intervening time of no precipitation exceeds 15 minutes. The format for the remark is given in paragraph 9.7.7.4.

5.3.4.7 Reporting Precipitation Amount. The amount of precipitation shall be reported at designated stations. The amounts reported are for accumulations during specific periods of time. The period and format for reporting these data are given in paragraphs 9.7.6.2 (precipitation amount), 9.7.6.3 (24-hour precipitation), and 9.7.7.5 (hourly precipitation).

5.4 Weather and Obstructions to Vision at Automated Stations

5.4.1 Determining Weather and Obstructions to Vision at Automated Stations. Automated stations with precipitation discrimination and/or access to thunderstorm data shall use the algorithms contained in the *Federal Standard Algorithms for Automated Weather Observing Systems Used for Aviation Purposes*. In accordance with those algorithms, automated stations shall report thunderstorms, time of beginning and ending of thunderstorms, location of thunderstorms, the type and intensity of precipitation, times of beginning and ending of precipitation, precipitation accumulation, and obstructions to vision.

5.4.2 Observing and Reporting Thunderstorms at Automated Stations.

5.4.2.1 Time of Beginning and Ending of Thunderstorms at Automated Stations. The beginning of a thunderstorm shall be the time cloud-to-ground lightning is detected within 10 miles of a station. The time a thunderstorm ended shall be 15 minutes after cloud-to-ground lightning was last detected within 10 miles of the station.

5.4.2.2 Reporting Thunderstorms at Automated Stations. Thunderstorms shall be reported in the body of the SAO in accordance with paragraphs 9.6.7. Designated stations shall include data on the time of beginning and/or ending in Remarks in accordance with paragraph 9.7.3.5.

5.4.3 Precipitation Occurrence at Automated Stations. As a minimum, precipitation shall be considered to be occurring when it is accumulating at a rate of at least 0.01 inch/hour (liquid equivalent).

5.4.3.1 Reporting the Type and Intensity of Precipitation at Automated Stations. At automated stations that have a precipitation discriminator, the type and intensity of precipitation occurring shall be reported in the body of all Record, Record Special, and Special observations using the notations given in Table 5-1. If the type cannot be determined it shall be reported as unknown precipitation using the notation "P−". The format for the report is given in paragraph 9.6.7.

5.4.3.2 Reporting Hourly Precipitation Amount at Automated Stations. The amount of precipitation including liquid equivalent of solid precipitation that has fallen since the last hourly observation shall be reported at all stations. The amount shall be reported in Remarks of all Record and Record Special observations. The format for the remark is given in paragraph 9.7.7.5.

5.4.3.3 Reporting 3- and 6-hourly Amounts of Precipitation at Automated Stations. At designated stations, if a trace or more of precipitation has occurred since the last 6-hourly observation, the amount of precipitation shall be reported as additive data in Remarks of the next 3- and 6-hourly observation. The amount reported shall be the amount of liquid precipitation that has fallen plus the liquid equivalent of any solid precipitation that has fallen in the period. The format for this remark is given in paragraph 9.7.6.2.

5.4.4 Reporting Obstructions to Vision at Automated Stations. Automated stations that have a precipitation discriminator shall report fog or haze as obstructions to visions in accordance with paragraph 5.3.2.

5.5 Weather and Obstructions to Vision at Manual Stations

5.5.1 Reporting a Tornado, Waterspout, or Funnel Cloud at Manual Stations. A tornado, waterspout, or funnel cloud shall be reported as an Urgent Special observation when it is observed by station personnel to begin and/or disappear. A Special shall be filed if a tornado, waterspout, or funnel cloud is reported by the public within 1 hour of its occurrence, and was not observed by station personnel. In addition to reporting the phenomenon in the body of the report in plain language, a remark shall be added defining the source, location, movement of the storm, and the time of beginning or ending. The format for the remark is given in paragraph 9.7.3.4.

5.5.2 Observing and Reporting Thunderstorms at Manual Stations.

5.5.2.1 Time of Beginning and Ending of Thunderstorms. A thunderstorm occurrence begins at the earliest time:

- thunder is heard, or
- lightning is observed over the station, and the local noise level is sufficient to prevent hearing thunder.

The time ascribed to the ending of a thunderstorm shall be 15 minutes after the last occurrence of any of the above criteria.

5.5.2.2 Determining Intensity of Thunderstorms at Manual Stations. The intensity of a thunderstorm shall be based on the following characteristics observed in the previous 15 minutes:

- Thunderstorm (T) - wind gusts less than 50 knots and, if there is hail, it is less than 3/4 inch in diameter.
- Severe Thunderstorm (T+) - wind gusts of at least 50 knots or hail at least 3/4 inch in diameter.

5.5.2.3 Reporting Thunderstorms at Manual Stations. Thunderstorms shall be reported in a Record, Record Special, or Special observation whenever they begin, are in progress, or end. In addition to reporting the phenomenon in the body of the report, a remark shall be added to report the location, movement of the storm, and the frequency and type of lightning in accordance with Table 5-8. The format for the remark is given in paragraph 9.7.3.5.

5.5.2.4 Reporting Lightning at Manual Stations. When lightning is observed the type, frequency, and location shall be reported in Remarks of Record, Record Special, and Special observations. The format for the remark is given in paragraph 9.7.3.12.

5.5.3 Observing Precipitation at Manual Stations. The standards and procedures given in paragraph 5.3.4 shall apply at manual stations.

5.5.3.1 Determining Type of Precipitation at Manual Stations. The type of precipitation shall be determined in accordance with the definitions given in paragraph 5.2.3. Unknown precipitation (P−) shall not be used at manual stations.

5.5.3.2 Determining the Intensity of Precipitation at Manual Stations. The intensity of precipitation shall be determined in accordance with paragraph 5.3.4.1. When more than one form of precipitation is occurring at a time or precipitation is occurring with an obstruction to vision, the intensities determined shall be no greater than that which would be determined if any forms were occurring alone.

Table 5-8. Type and Frequency of Lightning

Type of Lightning		
Type	**Contraction**	**Definition**
Cloud-ground	CG	Lightning occurring between cloud and ground.
In-cloud	IC	Lightning which takes place within the thunder cloud.
Cloud-cloud	CC	Streaks of lightning reaching from one cloud to another.
Cloud-air	CA	Streaks of lightning which pass from a cloud to the air, but do not strike the ground.
Frequency of Lightning		
Frequency	**Contraction**	**Definition**
Occasional	OCNL	Less than 1 flash/minute.
Frequent	FQT	About 1 to 6 flashes/minute.
Continuous	CONT	More than 6 flashes/minute.

5.5.3.3 Determining the Character of Precipitation at Manual Stations. The character of precipitation shall be determined to be either continuous, intermittent, or showery in accordance with the following:

- **Continuous**. If precipitation intensity changes, it changes gradually.
- **Intermittent**. Precipitation stops and starts at least once within the hour preceding the observation and, if the precipitation intensity changes, it changes gradually.
- **Showery**. Abrupt changes in precipitation intensity, or the precipitation starts and stops abruptly.

5.5.3.4 Determining the Depth of Freezing or Frozen Precipitation at Manual Stations. At designated stations, the depth of freezing and/or frozen precipitation shall be the actual vertical depth of the precipitation accumulated on a horizontal surface during the appropriate time period.

5.5.3.5 Determining Snow Depth at Manual Stations. For the purpose of depth measurements, the term snow shall include ice pellets, glaze, hail, any combination of these, and sheet ice formed directly or indirectly from precipitation. Therefore, if snow falls, melts, and refreezes, the depth of ice formed shall be included in depth measurements of snow.

5.5.4 Reporting Precipitation at Manual Stations. The type and intensity of precipitation shall be reported in the body of the SAO in accordance with paragraph 9.6.7 when it is observed to be falling at the station at the time the observation is made. Precipitation observed, but not falling at the station shall be reported in Remarks.

5.5.4.1 Reporting Precipitation Amount and Depth at Manual Stations. At designated stations, the amount of precipitation and the depth of freezing or frozen precipitation shall be reported in Remarks of 3- and 6-hourly observations. In addition, designated stations shall include reports of hourly precipitation in Record and, Record Special observations. The amounts reported are for accumulations during specific periods of time. Depths reported are the depths of solid precipitation determined at specified times. The coding specifications are given in paragraphs 9.7.5.2 (depth of snow), 9.7.6.2 (3- and 6-hourly amount), 9.7.6.3 (24-hour amount), and 9.7.7.5 (hourly precipitation).

5.5.4.2 Determining and Reporting Size of Hail at Manual Stations. The diameter of the largest hailstone that occurred during the latest event shall be estimated or measured, and reported in the Remarks of any observation reporting hail, and in the first Record or Record Special observation after the hail ends. The format for this remark is given in paragraph 9.7.3.6.

5.5.5 Determining and Reporting Obstructions to Vision at Manual Stations. Observers shall identify obstructions to vision as: fog, ground fog, blowing snow, blowing sand, blowing dust, blowing spray, ice fog, haze, smoke, dust, or volcanic ash, in accordance with the definitions given in paragraph 5.2.4. Obstructions to vision shall be reported in the body of the report only if the obstruction is at the station and the surface visibility is less than 7 miles. The notations given in Table 5-1 shall be used to report the obstructions to vision. If these conditions are not met, but an obstruction to vision is observed that is considered operationally significant, it shall be reported in Remarks as not at the station.

5.5.6 Observing and Reporting Other Significant Weather and Obstructions to Vision at Manual Stations. Observers shall be alert to weather and obstructions to vision that are visible from the station but not occurring at the station. Examples of such phenomena are fog banks, localized rain, snow blowing over runways, etc. These phenomena shall be reported in Remarks whenever they are observed and are considered by the observer to be operationally significant. The formats for these remarks are given in paragraph 9.7.3.13.

5.5.7 Reporting Volcanic Eruptions at Manual Stations. Volcanic eruptions shall be reported by a single element Urgent Special observation, whenever noted. The report shall be plain language and contain the following, if known:

- Name of volcano.
- Latitude and longitude or the direction and the approximate distance from the station.
- Date/Time (UTC) of the eruption.
- Size description, approximate height, and direction of movement of the ash cloud.
- Any other pertinent data about the eruption.
- EXAMPLE: HOM USP 1510 MT. AUGUSTINE VOLCANO 70 MILES SW ERUPTED 231505 LARGE ASH CLOUD EXTENDING TO APPROX 30000 FEET MOVING NE

Pre-eruption volcanic activity shall not be reported. Pre-eruption refers to unusual and/or increasing volcanic activity which could presage a volcanic eruption.

5.6 Weather and Obstructions to Vision at Augmented Stations.

5.6.1 Observing and Reporting Tornadic Activity at Augmented Stations. Observers shall report the occurrence of tornadoes, funnel clouds, and waterspouts in accordance with agency procedures.

5.6.2 Observing and Reporting Thunderstorms at Augmented Stations. Observers shall report the occurrence of thunderstorms in accordance with agency procedures.

5.6.3 Observing and Reporting Hail at Augmented Stations. Observers shall determine and report hail in accordance with agency procedures.

5.6.4 Observing and Reporting Volcanic Ash as an Obstructions to Vision at Augmented Stations. Observer shall report the occurrence of volcanic ash in accordance with agency procedures.

5.7 Summary of Weather and Obstructions to Vision Observing and Reporting Standards. Table 5-9 summarizes the weather and obstructions to vision observing and reporting standards at each category of station.

Table 5-9. Summary of Weather and Obstructions to Vision Observing and Reporting Standards

Weather Data	Type of Station		
	Automated	Augmented	Manual
Tornadic activity	Not reported.	Report TORNADO, FUNNEL CLOUD, and WATERSPOUT.	Report TORNADO, FUNNEL CLOUD, WATERSPOUT, time of beginning and time of ending, source, location, and direction of movement.
Thunderstorms	Not reported.	Report T.	Report T or T+, time of beginning and time of ending, location, and movement.
Hail	Not reported.	Report A	Report A, time of beginning and time of ending, estimated size of largest hailsone in inches preceded by "HLSTO".
Lightning	Not reported.		Report frequency, type, direction and distance from station.
Volcanic Eruption	Not reported.		Reports identification, location, time, and description of eruption.

Table 5-9 (Cont.). Summary of Weather and Obstructions to Vision Observing and Reporting Standards

Weather Data	Type of Station		
	Automated	Augmented	Manual
Obstructions to Vision	Not reported at AO1 stations. F and H reported at AO2 stations.	Report VOLCANIC ASH.	Report F, GF, IF, H, K, D, BS, BN, BD, BY, and VOLCANIC ASH.
	N/A	N/A	Reports non-uniform weather and obstructions to vision.
Precipitation	Not reported at AO1 stations. AO2 stations report R, ZR, S, and P—.	Report A.	Report R, RW, L, ZR, ZL, S, SW, SG, SP, IC, A, IP, and IPW.
	Do not report character of precipitation.	N/A	Report character of precipitation.
	Report the intensity of precipitation, other than IC and A as light, moderate, or heavy.	N/A	Report the intensity of precipitation, other than IC and A as light, moderate, or heavy.
	Reports hourly accumulation of liquid precipitation.	N/A	May report hourly accumulation of liquid precipitation.
	May report 3-, 6-, and 24-hour accumulation of precipitation (liquid equivalent of solid).	N/A	May report 3-, 6-, and 24-hour accumulation of precipitation (liquid equivalent of solid).
	N/A	N/A	May report depth and accumulation of solid precipitation.
	N/A	N/A	Reports size of hail.

CHAPTER 6

PRESSURE

6.1 General

Atmospheric pressure is the pressure exerted by the atmosphere at a given point.

6.2 Scope

This chapter describes the standards and procedures for determining and reporting the various forms of atmospheric pressure. In this chapter, the term "barometric pressure" refers to the actual pressure sensor value. The sensor value may be an altimeter setting, station pressure, or simply a raw pressure value depending on the type of sensor.

6.3 Pressure Parameters

- **Station pressure** (designated stations)

  The atmospheric pressure at the designated station elevation.

- **Altimeter setting**

  The pressure value to which an aircraft altimeter scale is set so that it will indicate the altitude above mean sea level of an aircraft on the ground at the location for which the value was determined.

- **Sea-level pressure** (designated stations)

  A pressure value obtained by the theoretical reduction of barometric pressure to sea level. Where the Earth's surface is above sea level, it is assumed that the atmosphere extends to sea level below the station and that the properties of that hypothetical atmosphere are related to conditions observed at the station.

6.4 Pressure Standards and Procedures Applicable to All Stations

6.4.1 Pressure Sensor Accuracy and Resolution. Pressure sensors shall have an accuracy of ± 0.02 inches of mercury. The resolution of the pressure sensor shall be at least 0.005 inches of mercury.

6.4.2 Pressure Sensor Range. Pressure sensors shall be capable of measuring pressure over a 4-inch range.

6.4.3 Barometer Comparisons. Each agency shall establish an agency standard barometer traceable to the standard of the National Institute of Standards and Technology. The agency shall also establish a system of routine barometer comparisons to determine corrections required to keep the station's pressure sensors within the required accuracy given in paragraph 6.4.1.

6.4.4 Determining Atmospheric Pressure. The various pressure parameters shall be determined from the barometric pressure after appropriate corrections are applied. The method used shall depend on the type of sensor and the available computational aids. These aids may be systems that result in a direct readout of the desired parameter, pressure reduction calculators, or tables. Designated stations may use constants to convert measured pressure to the desired pressure parameter.

Approved system algorithms for computing station pressure, sea-level pressure, and altimeter setting are given in the *Federal Standard Algorithms for Automated Weather Observing Systems Used for Aviation Purposes*.

6.4.4.1 Determining Station Pressure. Station pressure shall be determined by adjusting the corrected barometric pressure to compensate for the difference between the height of the barometer and the designated station elevation.

6.4.4.2 Determining Sea-level Pressure. Sea-level pressure shall be computed at designated stations by adjusting the station pressure to compensate for the difference between the station elevation and sea-level. This adjustment shall be based on the station elevation and the 12-hour mean temperature at the station. The 12-hour mean temperature shall be the average of the present ambient temperature and the ambient temperature 12 hours ago.

Stations within $\pm$ 50 feet of sea-level may be authorized by their agency to use a constant value to adjust station pressure to sea-level pressure. Otherwise, stations shall use reduction ratios provided by their responsible agency to calculate sea-level pressure.

6.4.4.3 Determining Altimeter Setting. The altimeter setting shall be determined either directly from an altimeter setting indicator or computed from the station pressure by applying a correction for the difference between the station elevation and field elevation in the standard atmosphere. Where this difference is 30 feet or less, agencies may authorize the use of a constant correction.

6.4.4.4 Determining Pressure Change Remarks. The pressure calculated for each SAO report shall be examined to determine if a pressure change remark is required. If the pressure is rising or falling at a rate of at least 0.06 inch per hour and the pressure change totals 0.02 inch or more at the time of the observation, a pressure change remark shall be included in the Remarks of the SAO.

6.4.4.5 Determining Pressure Tendency Remark. Designated stations shall include a pressure tendency remark in each 3- and 6-hourly observation. The pressure tendency remark includes two parts: the characteristic (an indication of how the pressure has been changing over the past three hours) and the amount of the pressure change in the past three hours. The characteristic shall be based on the observed or recorded changes in pressure over the past three hours. The amount of pressure change is the absolute value of the change in station pressure or altimeter setting in the past three hours converted to tenths of hectopascals[1]. The format for this remark is given in paragraph 9.7.6.1.

6.4.5 Pressure Reporting Standards. Sea-level pressure and altimeter setting, when determined, shall be reported in the body of the SAO. Other pressure data, when reported, shall be reported in Remarks. The coding procedures and formats used to report pressure parameters in the SAO are given in paragraphs 9.6.8 (sea-level pressure), 9.6.12 (altimeter setting), 9.7.6.1 (pressure tendency), 9.7.3.15 (pressure unsteady), 9.7.3.16 (barogram V), and 9.7.7.9 (pressure change).

6.4.5.1 Units of Measure and Resolution. Table 6-1 lists the units of measure and the resolution for the pressure parameters.

Table 6-1. Units of Measure and Resolution of Pressure Parameters

Parameter	Unit of Measure	Resolution
Station Pressure	Inches of Mercury	0.005 inch
Altimeter Setting	Inches of Mercury	0.01 inch
Sea-Level Pressure	Hectopascals	0.1 hectopascal

6.4.5.2 Reporting Frequency of Sea-Level Pressure. At designated stations, sea-level pressure shall be reported in all Record and Record Special observations.

6.4.5.3 Reporting Frequency of Altimeter Setting. Altimeter setting shall be reported in all Record, Record Special, and Special observations.

6.4.5.4 Reporting Frequency of Pressure Remarks. The pressure change remarks shall be included in all SAOs. The pressure tendency remark shall only be included in 3-hourly and 6-hourly observations.

6.5 Pressure Standards and Procedures at Automated Stations

6.5.1 Pressure Sensor Accuracy at Automated Stations. The pressure sensor system shall be designed to provide pressure measurements with the accuracy given in paragraph 6.4.1 at least 99 percent of the time.

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[1]Hectopascals are the numerical equivalent of millibars.

6.5.2 Determining Pressure at Automated Stations. In accordance with the *Federal Standard Algorithms for Automated Weather Observing Systems Used for Aviation Purposes*, the pressure algorithms compute a pressure relative to the field elevation and then based on that value, compute the pressure parameters listed in paragraph 6.3. Computations are made each minute. In addition to the parameters listed in paragraph 6.3, a pressure algorithm also generates pressure change and pressure tendency remarks for all required SAO reports.

6.6 Pressure Standards and Procedures at Manual Stations

The standards in paragraph 6.5 are applicable at designated manual stations with automated surface weather observing systems.

6.6.1 Determining the Pressure Tendency Remark at Manual Stations. Designated manual stations with automated surface weather observing systems shall determine the pressure tendency remark in accordance with paragraph 6.5.2. Other manual stations shall determine the characteristic from the appearance of the barogram trace, provided a barograph is available for the three-hour period, otherwise base it on changes in hourly values of the altimeter setting or the station pressure over the past three hours. The amount of pressure change is the absolute value of the change in either the altimeter setting or the station pressure in the past three hours converted to tenths of hectopascals.

6.6.2 Additional Pressure Remarks at Manual Stations. Stations having a microbarograph shall evaluate the barogram trace and generate the following remarks when appropriate.

6.6.2.1 Pressure Unsteady. When the barogram trace indicates sharp troughs or crests that depart at least 0.03 inch from the mean trend, the pressure shall be reported as unsteady in Remarks of the next observation. The format for the remark is given in paragraph 9.7.3.15.

6.6.2.2 Barogram V. When the barogram indicates a fall in pressure at the rate of 0.06 inch or more per hour, followed by an abrupt rise at the rate of 0.06 inch or more per hour, and both the fall and rise each equal 0.03 inch or more, a barogram V remark shall be included in the next Record observation. The format for the remark is given in paragraph 9.7.3.16.

6.7 Summary of Pressure Observing and Reporting Standards

Table 6-2 summarizes the pressure observing and reporting procedures at each category of station.

Table 6-2. Summary of Pressure Observing and Reporting Standards

Pressure Data	Type of Station	
	Automated	Manual
Sea-level pressure	Reported in hectopascals at designated AO1 stations and at all AO2 stations.	Reported in hectopascals at designated stations.
Altimeter Setting	Reported in inches of mercury at all stations.	
Remarks		
Rising Rapidly	Reported at all stations.	
Falling Rapidly	Reported at all stations.	
Tendency	May be reported	
Unsteady	N/A	May be reported at stations with barographs.
Barogram V	N/A	May be reported at stations with barographs.

CHAPTER 7

TEMPERATURE AND DEW POINT

7.1 General.

This chapter prescribes the observing and reporting standards for temperature and dew point that appear in the SAO reports. The chapter also defines maximum and minimum temperature and prescribes appropriate standards.

7.2 Temperature and Dew Point.

- **Temperature**

  The degree of hotness or coldness of the ambient air as measured by any suitable instrument.

- **Dew point** (designated stations)

  The temperature to which a given parcel of air must be cooled at constant pressure and constant water-vapor content in order for saturation to occur.

- **Maximum temperature** (designated stations)

  The highest temperature during a prescribed time period.

- **Minimum temperature** (designated stations)

  The lowest temperature during a prescribed time period.

7.3 Temperature and Dew-Point Observing Standards.

The method of obtaining temperature and dew point varies according to the system in use at the station. The data may be read directly from digital or analog readouts, or calculated from other measured values.

7.3.1 Temperature and Dew-Point Sensor Range, Accuracy, and Resolution. The range for the temperature and dew-point sensors shall be determined by the responsible agency considering the local climatology. The sensors shall have the accuracy and resolution specified in Table 7-1.

Table 7-1. Temperature and Dew-Point Sensor Accuracy and Resolution (in deg F)

Parameter	Range	Accuracy	Resolution
Temperature	−80 to −58	±2	0.1
	−58 to +122	±1	0.1
	+122 to +130	±2	0.1
Dew point	−30 to −11	±4	0.1
	−11 to +30	±3	0.1
	+30 to +86	±2	0.1

7.3.2 Determining Temperature. Temperature shall be determined at all stations.

7.3.3 Determining Dew Point. Dew point shall be determined at designated stations.

7.3.4 Determining Maximum and Minimum Temperature. At designated stations, maximum and minimum temperatures that occurred in the previous 6 hours shall be determined to the nearest whole degree Fahrenheit for the 0000, 0600, 1200, and 1800 UTC observations. The maximum and minimum temperatures for the previous 24 hours shall be determined for the 0000 LST observation.

7.4 Temperature and Dew-Point Reporting Standards

7.4.1 Units of Measure and Resolution for Reporting Temperature and Dew Point. The units of measure and reporting resolution for the various temperatures and the dew point shall be degrees Fahrenheit. Dew point shall be calculated with respect to water at all temperatures.

7.4.2 Reporting Frequency.

7.4.2.1 Reporting Frequency for Temperature and Dew Point. At stations determining these data, the temperature and dew point shall be reported in all scheduled observations and all special observations taken upon notification of an aircraft mishap at or in the vicinity of the station.

7.4.2.2 Reporting Frequency for Maximum and Minimum Temperatures. At designated stations, maximum and minimum temperatures shall be reported as additive data in the 0000, 0600, 1200, and 1800 UTC and 0000 LST observations.

7.4.3 Reporting Procedures. Temperature and dew point are reported in the body of the SAO in accordance with paragraphs 9.6.9 and 9.6.10, respectively. Maximum and minimum temperatures are reported in remarks in the formats given in paragraphs 9.7.6.4, 9.7.6.5, and 9.7.6.6.

7.5 Temperature and Dew Point at Automated Stations.

Temperature and dew point shall be determined at all automated stations; maximum and minimum temperature shall be determined at designated automated stations.

7.5.1 Determining Temperature and Dew Point at Automated Stations. At automated stations, in accordance with *Federal Standard Algorithms for Automated Weather Observing Systems Used for Aviation Purposes*, the temperature and dew-point algorithms shall calculate 5-minute average values of temperature and dew point.

7.5.2 Determining Maximum and Minimum Temperatures at Automated Stations. At automated stations, the maximum and minimum temperatures shall be based on the highest and lowest 5-minute average temperatures during the period of evaluation.

7.6 Temperature and Dew Point at Manual Stations.

The standards in paragraph 7.5 are applicable at designated manual stations with automated surface weather observing systems.

Temperature shall be determined and reported at all manual stations. Dew point and maximum and minimum temperatures shall be determined and reported at designated stations.

7.7 Summary of Temperature and Dew-Point Observing and Reporting Standards.

Table 7-2 summarizes the temperature and dew-point observing and reporting procedures at each category of station.

Table 7-2. Summary of Temperature and Dew-Point Observing and Reporting Standards

Parameter	Type of Station	
	Automated	Manual
Temperature	Reported in degrees Fahrenheit at all stations.	
Dew point	Reported in degrees Fahrenheit at designated stations.	
Maximum and minimum temperatures	Designated stations report at 0000, 0600, 1200, and 1800 UTC.	
24-hour maximum and minimum temperatures	Designated stations report at 0000 LST.	

CHAPTER 8

WIND

8.1 General.

Wind shall be measured in terms of velocity, a vector that includes direction and speed. The absence of apparent motion of the air shall be termed "calm".

8.2 Scope.

This chapter prescribes the observing and reporting standards for wind data in SAO reports.

8.3 Wind Parameters.

As used in this chapter, wind is the horizontal motion of the air past a given point and includes:

- **Direction**

  The direction, in degrees, from which the wind is blowing.

- **Speed**

  The rate, in knots, at which the wind passes a given point.

- **Character**

  The description of the variability of the wind speed (gusts and squalls).

- **Peak wind speed** (designated stations)

  The highest wind speed measured whenever it exceeds 25 knots.

- **Wind Shift**

  A change in wind direction of 45 degrees or more with sustained winds of 10 knots or more.

8.4 Wind Observing Standards.

Wind direction, speed, character, and wind shifts shall be determined at all stations. Peak wind shall be determined at designated stations.

8.4.1 Wind Sensor Range, Accuracy, and Resolution. Table 8-1 depicts the required range, accuracy, and resolution for wind sensors.

Table 8-1. Wind Sensor Range, Accuracy, and Resolution

Parameter	Range	Accuracy	Resolution
Direction	1 to 360 degrees	±5 degrees when speed is ≥5 knots	10 degrees
Speed and Character	2 to 90 knots	±1 knot up to 10 knots ±10% above 10 knots	1 knot

8.4.2 Determining Wind Direction. The wind direction shall be determined by averaging the direction over a 2-minute period.

8.4.3 Determining Variable Wind Direction. The wind direction shall be considered variable if, during the 2-minute evaluation period, it varies by 60 degrees or more when the average wind speed is greater than 10 knots.

8.4.4 Determining Wind Speed. The wind speed shall be determined by averaging the speed over a 2-minute period.

8.4.5 Determining Wind Character. The wind speed data for the most recent 10 minutes shall be examined to evaluate the occurrence of gusts or squalls. These are indicated by fluctuations of the speed as follows:

- **Gusts**

  indicated by rapid fluctuations in wind speed with a variation of 10 knots or more between peaks and lulls.

- **Squalls**

  indicated by a sudden increase in wind speed of at least 15 knots which is sustained at 20 knots or more for at least 1 minute.

The speed of a gust or squall shall be the maximum instantaneous wind speed measured in the last 10 minutes.

8.4.6 Determining Peak Wind Speed. Peak wind data shall be determined at stations with wind speed recorders (including automated wind systems with internal storage of wind data). The peak wind speed shall be the highest instantaneous speed measured since the last Record observation.

8.4.7 Determining Wind Shifts. The two-minute averages of wind data shall be examined to determine the occurrence of a wind shift. A wind shift is indicated by a change in wind direction of 45 degrees or more over a 15-minute period with sustained winds of 10 knots or more.

8.5 Wind Reporting Standards.

8.5.1 Units of Measure and Resolution for Wind Reports. Table 8-2 describes the units and resolution for reports of wind data.

Table 8-2. Reporting Units and Resolution of Wind Data

Parameter	Units	Resolution
Direction	degrees	10 degrees
Speed and Character	knots	1 knot

8.5.2 Reporting Wind Direction and Speed. Wind direction and speed shall be reported in the body of all SAOs. Direction shall be reported in tens of degrees with reference to true north and speed shall be reported in knots. The format for reporting these data is given in paragraph 9.6.11.

8.5.2.1 Reporting Calm Winds. When no motion of air is detected, the wind shall be reported as calm; i.e., both the direction and speed shall be reported as 00.

8.5.2.2 Reporting Variable Wind Direction. When the wind direction is variable, and the speed is greater than 10 knots, a variable wind remark shall be included in the SAO report. The format for this remark is given in paragraph 9.7.7.7.

8.5.3 Reporting Wind Character. When a gust or squall is detected within 10 minutes prior to an observation that includes wind, the character of the wind and the associated speed shall be reported in the body of the observation. The format for reporting the wind character is given in paragraph 9.6.11.

8.5.4 Reporting Wind Shifts. A Special observation shall be taken immediately after a wind shift occurs. A remark reporting the wind shift, and the time the wind shift occurred, shall be included in the observation. When the Special observation reporting a wind shift is not given long-line dissemination, the wind shift remark shall be included in the next transmitted report. The format for the remark is given in paragraph 9.7.7.6.

8.5.5 Reporting Peak Wind Data. Peak wind data shall be reported in Remarks of Record and Record Special observations whenever the peak wind speed exceeds 25 knots. The format for the remark is given in paragraph 9.7.7.8.

8.6 Wind at Automated Stations.

8.6.1 Wind Sensor Performance at Automated Stations. The wind direction and speed sensor shall provide the system processor with sufficient data to compute 5-second and 2-minute average wind directions and speeds.

8.6.2 Determining Wind at Automated Stations. In accordance with the *Federal Standard Algorithms for Automated Weather Observing Systems Used for Aviation Purposes*, the wind algorithm uses 5-second average wind directions and speeds to compute 2-minute averages for reporting direction and speed. The 5-second average speed represents an instantaneous wind and is used to determine gusts, squalls, and peak wind data. The 2-minute average direction is used to determine wind shifts and the range of variability for variable wind direction reports.

8.7 Wind at Manual Stations.

The standards and procedures in paragraphs 8.4 (observing) and 8.5 (reporting) apply to wind at manual stations. In addition, the standards in paragraph 8.6 apply at designated manual stations with automated surface weather observing systems.

8.7.1 Estimating Wind Direction at Manual Stations. When the wind direction sensor(s) is out of service, the direction may be estimated by observing the wind cone or tee, movement of twigs, leaves, smoke, etc., or by facing into the wind in an unsheltered area. When estimating wind direction, note that even small obstacles may cause variations in the wind direction.

8.7.2 Estimating Wind Speed at Manual Stations. When instruments are out of service, or the wind speed is below the starting speed of the anemometer in use, Table 8-3 shall be used to estimate wind speeds.

8.7.3 Determining Wind Character at Manual Stations. The existence of gusts or squalls shall be determined only when wind speed recorders are available. The speed of a gust or squall shall be the maximum instantaneous wind speed observed. The observing procedures in paragraph 8.4.5 apply to wind character.

8.7.4 Determining Peak Wind at Manual Stations. Peak wind shall be determined from a recorder. The speed of the peak wind shall be the maximum instantaneous wind speed recorded. The observing procedures in paragraph 8.4.6 apply to peak wind. (Note: Peak wind is not reported unless it exceeds 25 knots.)

Table 8-3. Estimating Wind Speed

Knots	Specification	Knots	Specification
< 1	Calm; smoke rises vertically.	22-27	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
1-3	Direction of wind shown by smoke drift not by wind vanes.	28-33	Whole trees in motion; inconvenience felt walking against wind.
4-6	Wind felt on face; leaves rustle; vanes moved by wind.	34-40	Breaks twigs off trees; impedes progress.
7-10	Leaves and small twigs in constant motion; wind extends light flag.	41-47	Slight structural damage occurs.
11-16	Raises dust, loose paper; small branches moved.	48-55	Trees uprooted; considerable damage occurs.
17-21	Small trees in leaf begin to sway; crested wavelets form on inland waters.	56-71	Widespread damage.

8.8 Summary of Wind Observing and Reporting Standards.

Table 8-4 summarizes the wind observing and reporting standards at each category of station.

Table 8-4. Summary of Wind Observing and Reporting Standards

Parameter	Type of Station	
	Automated	Manual
Wind direction	2-minute average in 10 degree increments with respect to true north is reported at all stations.	
Wind speed	2-minute average speed in knots is reported at all stations.	
Wind character	The character, gust or squall, with the highest instantaneous speed in knots in the past 10 minutes is reported at all stations with a means of recording the wind speed.	
Peak wind	Highest instantaneous speed in knots since last Record observation is reported at all stations with a means of recording the wind speed.	
Wind shifts	Windshift and the time the shift occurred is reported at all stations.	

CHAPTER 9

CODING AND DISSEMINATION

9.1 General.

This chapter contains procedures for encoding a weather observation in surface aviation observation (SAO) code format for dissemination.

9.2 Scope.

The coding procedures in this chapter apply only to the SAO code format. This chapter also discusses the types of dissemination and the general requirements for verifying and making corrections to disseminated observations.

9.3 Surface Aviation Observation Code.

The SAO code has two major sections: the Body of the report, consisting of 12 elements; and the Remarks section, consisting of 6 groups of Remarks. Together, they make up the complete SAO code and, in general, are reported in the following order:

- Body of report
  - Station Identifier (iii)
  - Type of Observation (FM)
  - Time of Observation (GGgg)
  - Type of Station ($M_iM_iM_jM_j$)
  - Sky Condition (SKY)
  - Surface Visibility (VV)
  - Weather and Obstructions to Vision (ww)
  - Sea-level Pressure (PPP)
  - Temperature (TT)
  - Dew Point (T_dT_d)
  - Wind Direction (dd), Speed (ff), and Character (GQ)
  - Altimeter Setting (ALSTG)
- Remarks section of report
  - Runway Visual Range (RVR)
  - Operationally Significant Remarks (OSR)
  - Special Notices (SPN)
  - Other Coded Remarks (OCR)
  - Additive Data (AD)
  - Remarks Elaborating on Other Coded Data (RECD)

9.4 Format and Content of the SAO Report.

In the following format for the SAO, the abbreviations used are those given in parenthesis in paragraph 9.3. The underline character "_" indicates a required space, and the solidus "/" indicates a required solidus for the body of the observation. The underline character "_" indicates a required space and the solidus "/" indicates a required solidus only to separate those remark groups that are actually reported. In addition to the format given, agencies shall provide for the inclusion of any special Beginning-of-Message, End-of-Message, or End-of-Transmission signals required by their communications system.

iii_FM_GGgg_$M_iM_iM_jM_j$_SKY_VVww_PPP/TT/T_dT_d/ddffGQ/ALSTG/_RVR/_OSR/_SPN/_OCR/_AD/_RECD

The actual content of an SAO depends on the observation program at the individual station. The generalized content of the different types of SAO reports is shown in Tables 2-2, 9-1, 9-9, 9-11, 9-12, 9-13, and 9-15.

9.5 Coding Missing Data in the SAO.

If any element of the observation is missing because of sensor failure, and there is no backup data available, the element shall be encoded with an "M", if it is normally included in the body of the observation and encoded with a solidus "/", if normally included in Remarks. This applies equally to those elements that are normally only reported when they occur, such as weather and obstructions to vision, precipitation amounts, etc. For example, if the sensor used to measure liquid precipitation is out of service, and no other sensor is available to measure the precipitation, the amount of precipitation would be reported as 6//// in the next 3- or 6-hourly observation to indicate that the precipitation amount is missing or indeterminate. If sky condition was missing, the report would be MM; one M for the missing height, the other M for the missing amount. Missing wind data would also be encoded MM, one M for the missing direction, the other M for the missing speed.

9.6 Coding the Body of the SAO.

Table 9-1 indicates the applicability of the code groups addressed in the following paragraphs to the various types of stations. The table also indicates whether or not the data are included in Record (including Record Special) observations and Special observations.

Table 9-1. Guide to Contents of the Body of the SAO

Element of SAO Report	Type of Station:	AO1		AO1A		AO2		AO2A		Manual	
	Type of Observation:	SA	SP	SA	SP	SA	SP	SA	SP	SA	SP
Station Identifier (9.6.1)		X	X	X	X	X	X	X	X	X	X
Type of Observation (9.6.2)		X	X	X	X	X	X	X	X	X	X
Time of Observation (9.6.3)		X	X	X	X	X	X	X	X	X	X
Type of Station (9.6.4)		X	X	X	X	X	X	X	X		
Sky Condition (9.6.5)											
≤ 12,000 feet		X	X	X	X	X	X	X	X	X	X
> 12,000 feet										X	X
Surface Visibility (9.6.6)		X	X	X	X	X	X	X	X	X	X
Weather & Obstructions to Vision (9.6.7)				D	D	X	X	X	X	X	X
Sea-level Pressure (9.6.8)		D	D	D	D	X	X	X	X	D	
Temperature (9.6.9)		X	X	X	X	X	X	X	X	X	S
Dew Point (9.6.10)		X	X	X	X	X	X	X	X	D	S/D
Wind Direction, Speed, and Character (9.6.11)		X	X	X	X	X	X	X	X	X	X
Altimeter Setting (9.6.12)		X	X	X	X	X	X	X	X	X	X

X - Indicates elements included at all stations.
D - Indicates elements included only at designated stations.
S - Indicates elements included in Special observations taken because of an Aircraft Mishap but not included in other Special observations.

9.6.1 Station Identifier. The station identifier shall be included in all reports to identify the station to which the coded report applies.

The station identifier shall consist of three or four alphanumeric characters. The identifier shall be assigned by the agency with operational control in coordination with the FAA at the time the station is first established. A list of approved identifiers can be found in the FAA Manual 7350 Series, *Location Identifiers*. The station identifier shall be separated from elements following it by a space.

9.6.2 Type of Observation. The type of observation shall be included in all reports to indicate the content of the observation. The type of observation shall be encoded using Table 9-2. The type of observation shall be separated from elements following it by a space.

Table 9-2. Encoding Type of Observation

Type of Observation	Code Figure
Record (2.4.2)	SA
Record Special (2.4.2)	RS
Special (2.4.3)	SP
Urgent Special (2.4.4)	USP
Correction (9.6.3)	COR*
Routine Delayed Report (see Delayed Reports, paragraph 9.10)	RTD**

* COR shall be placed after the type of observation separated by a space.
** RTD is optional, but if used, shall be placed after the type of observation separated by a space.

9.6.3 Time of Observation. The time of observation shall be included in all reports. The time shall be the actual time of observation (see paragraph 2.5.3.3). If the report is a correction to a previously disseminated erroneous report, the time entered on the corrected report shall be the same time used in the observation being corrected. The time of observation shall be separated from elements following it by a space. For example, XYZ SA AO2A 0853 would be at the beginning of the 0900 scheduled observation from station XYZ taken at 0853 UTC.

9.6.4 Type of Station. This part of the report identifies the type of station. It shall be included in all reports from automated and augmented stations. The type of station shall be encoded using Table 9-3, unless the table is not applicable. (AMOS, RAMOS, and AUTOB stations shall continue to report their type of station.) Absence of a code figure indicates a manual station.

9.6.5 Sky Condition. The standards and procedures for observing sky condition are given in Chapter 3. As a minimum, it shall describe the observed sky condition from the surface to 12,000 feet at the time of observation. The entries shall be made in ascending order of height of the bases of each layer.

If there are more than three layers present and the report is to be truncated to 3 layers, the layers reported shall be selected in accordance with paragraph 3.4.3.1.

Each layer shall be separated from other layers or data by a space. The sky cover for each layer reported shall be indicated by using the appropriate reportable value from Table 9-4. The report of clear skies (CLR or CLR BLO xxx) and partial obscurations (−X) are complete layer reports within themselves. Otherwise, the contraction shall be preceded by a space and the height of the layer.

Table 9-3. Encoding Type of Station

Type of Station	Code Figure
Automated without a precipitation discriminator	AO1
Automated without precipitation discriminator with augmentation capability and an observer signed on	AO1A
Automated with precipitation discriminator	AO2
Automated with precipitation discriminator with augmentation capability and an observer signed on	AO2A
Absence of a code figure indicates a manual station. A remark "NOSPL" shall be added to manual observations where Specials are not taken.	

Table 9-4. Reportable Values for Sky Cover Amount

Reportable Value	Meaning	Summation Amount of Layer	
		Military	Civilian
-X[1]	Partial Obscuration	<1.0	<1.0
X	Obscured Sky	1.0	1.0
CLR[2]	Clear	0	0 - <0.1
SCT[3]	Scattered	>0 - 0.5	>0.1 - 0.5
BKN[3]	Broken	0.6 - <1.0	0.6 - 0.9
OVC[3]	Overcast	1.0	>0.9 - 1.0

1. Manual observations only.
2. For automated and augmented observations, when no clouds are detected within the range of the sensor, "CLR BLO xxx" shall be reported, where xxx is within range of the ceilometer.
3. For manual observations, prefix these values with a "-" if the layer is thin (see paragraph 3.5.1.6).

The height of the base of each layer shall be reported in hundreds of feet above the surface using the increments given in Table 9-5. If the actual height falls between two reportable values, the lower value shall be reported.

Table 9-5. Increments of Reportable Values of Sky Cover Height

Range of Height Values (feet)	Reportable Increment (feet)
5,000 or less	To nearest 100
>5,000 but ≤ 10,000	To nearest 500
Above 10,000	To nearest 1,000

The height of the lowest layer that is reported obscured, broken, or overcast and is not classified thin shall be considered to be the ceiling and shall be prefixed with the appropriate ceiling designator in accordance with Table 9-6. These designators are defined in paragraph 3.4.3.4 (automated and augmented stations) and paragraph 3.5.2.5 (manual stations).

For example, a sky condition encoded −X 12 SCT M35 BKN 100 OVC would indicate a partially obscured sky, with a scattered layer at 1,200 feet, a ceiling layer that was broken at a measured 3,500 feet, and an overcast layer at 10,000 feet. An example of a report of clear skies from an automated system would be CLR BLO 120.

Table 9-6. Ceiling Designator Code Figures

Type of Ceiling	Ceiling Designator Code
Measured	M
Estimated	E
Indefinite	W

When the ceiling is variable (see paragraphs 3.3.3.1 and 3.3.5.7), the height shall be suffixed with a "V", for example, M15V OVC. A remark shall be included in the observation to define the range of variability (see paragraph 9.7.7.1).

When the sky condition is not available, the report shall be encoded MM.

9.6.6 Surface Visibility. The standards and procedures for determining and reporting visibility are given in Chapter 4. The surface visibility shall be followed immediately by any reported weather or obstructions to vision. Otherwise, surface visibility shall be separated from the data that follows by a space.

The surface visibility shall be encoded in statute miles using the values listed in Table 9-7. If the actual visibility falls halfway between two reportable values, the lower value shall be reported. For example, a visibility of 4 1/2 miles would be reported as 4 miles.

If the visibility is less than 3 miles and is varying by 1/2 mile or more while it is being determined, the visibility shall be reported as variable (see paragraph 4.4.3) by placing a "V" immediately following the reported visibility value. For example, 2V would indicate a visibility of two miles that was varying by at least 1/2 mile during the time the visibility was determined. The actual range of variability would be given in Remarks (see paragraph 9.7.7.3).

Table 9-7. Reportable Visibility Values

Type of Station							
Automated			Manual				
< 1/4	1 1/2	4	0	3/4	1 7/8	7	20
1/4	1 3/4	5	1/16	7/8	2	8	25
1/2	2	7	1/8	1	2 1/4	9	30
3/4	2 1/2	10	3/16	1 1/8	2 1/2	10	35
1	3		1/4	1 1/4	2 3/4	11	40
1 1/4	3 1/2		5/16	1 3/8	3	12	45
			3/8	1 1/2	4	13	50
			1/2	1 5/8	5	14	55
			5/8	1 3/4	6	15	etc.

9.6.7 Weather and Obstructions to Vision. The standards and procedures for determining and reporting weather and obstructions to vision are described in Chapter 5.

Only weather occurring at the station shall be reported in the body of the report. Obstructions to vision occurring at the station shall be reported in the body of the report only if the surface visibility is less than 7 miles. (Weather and/or obstructions to vision observed to be occurring at a distance from the station shall be reported in Remarks.)

The appropriate notations given in Table 9-8 shall be used to indicate the type(s) of weather or obstruction to vision.

If the character of precipitation is showery (see paragraph 5.5.3.3), the type of precipitation shall be suffixed with a "W." If the precipitation falling at the time of the observation is intermittent (see paragraph 5.5.3.3), the character is reported as a remark (see paragraph 9.7.3.7).

No intensity shall be given to hail or ice crystals. Otherwise, if the intensity of precipitation is light or heavy, the type shall be suffixed with a "−" or "+", respectively. Therefore, the absence of a symbol shall indicate moderate precipitation unless the reported weather is hail or ice crystals.

Weather and obstructions to vision occurring at the station shall immediately follow the reported surface visibility and be separated from the element following it by a space.

Table 9-8. Notations for Reporting Weather and Obstructions to Vision

Type of Phenomenon	Reporting Notation	Type of Phenomenon	Reporting Notation
TORNADO	TORNADO	Snow Grains	SG
FUNNEL CLOUD	FUNNEL CLOUD	Snow Pellets	SP
WATERSPOUT	WATERSPOUT	Volcanic Ash	VOLCANIC ASH
Severe Thunderstorm	T+	Fog	F
Thunderstorm	T	Ground Fog	GF
Unknown Precipitation[1]	P−	Ice Fog	IF
Rain	R	Blowing Dust	BD
Drizzle	L	Blowing Sand	BN
Freezing Rain	ZR	Blowing Snow	BS
Freezing Drizzle	ZL	Blowing Spray	BY
Ice Crystals	IC	Dust	D
Ice Pellets	IP	Haze	H
Hail	A	Smoke	K
Snow	S		

1. Used only by automated system when type of light precipitation is not recognized by the precipitation discrimination system.

Multiple occurrences of weather and obstructions to vision shall be entered in the order prescribed by paragraph 5.3.3. For example, a thunderstorm occurring with hail, and rain with a visibility of 3 miles would be encoded 3TRA.

9.6.8 Sea-level Pressure. The standards and procedures for observing and reporting sea-level pressure are given in paragraph 6.4.4.2.

Sea-level pressure shall be separated from the element following it with a solidus "/." Sea-levelpressure shall be encoded as a three character group representing the pressure in tenths of hectopascals, using the last three digits with the decimal point omitted. For example, a sea-level pressure of 998.2 hectopascals would be encoded 982/.

9.6.9 Temperature. The standards and procedures for observing and reporting temperature are given in paragraph 7.4. The temperature shall be separated from the elements following it with a solidus "/".

The temperature shall be entered to the nearest whole degree Fahrenheit. Sub-zero temperatures shall be prefixed with a "–." For example, a portion of a report such as 982/–12/ would indicate a temperature of 12 degree Fahrenheit below zero. A report of 982/107/ would indicate a temperature of 107 degree Fahrenheit.

9.6.10 Dew Point. The standards and procedures for observing and reporting dew point are given in paragraph 7.4. The dew point temperature shall be separated from the elements following it with a solidus "/".

The dew point temperature shall be entered to the nearest whole degree Fahrenheit. Sub-zero temperatures shall be prefixed with a minus sign. For example, a report of 982/2/–7/ would indicate a dew point of 7 degree Fahrenheit below zero and 982/2/M/ would indicated a missing dew point. When the dry-bulb temperature is -30 degrees Fahrenheit or below, the dew point shall be reported missing.

9.6.11 Wind Direction, Speed, and Character. The standards and procedures for determining and reporting wind are given in paragraphs 8.4 and 8.5.

The wind data shall be separated from the elements following it with a solidus "/."

The true direction from which the wind is blowing shall be reported in tens of degrees. Directions less than 100 degrees shall be preceded with a "0". When the wind is calm, "00" shall be entered for the direction.

The wind speed shall be entered as a two or three digit group immediately following the wind direction. The speed shall be entered in whole knots using the hundreds digit (if not zero) and the tens and units digits. Speeds of less than 10 knots shall be encoded using a leading zero. For example, a wind speed of 8 knots shall be encoded 08. A wind speed of 112 knots shall be encoded 112. When the wind speed is determined to be calm, "00" shall be entered for speed.

If gusts or squalls have been observed during the 10 minutes prior to the actual time of observation (see paragraphs 8.4.5 and 8.5.3), "G" for gust or "Q" for squall, as appropriate, shall be entered immediately following the wind speed and be followed by the highest instantaneous speed in the 10-minute period. For example, a wind from the west at 20 knots with gusts of 35 knots would be encoded /2720G35/.

Whenever either the reported wind direction or wind speed is estimated, the direction shall be prefixed with an "E". An example is a wind from 360 degrees at an estimated 15 knots would be encoded E3615. If either the wind direction or speed is missing, it shall be encoded M. If both the wind direction and speed are missing, the data shall be encoded MM.

9.6.12 Altimeter Setting. The standards and procedures for determining and reporting altimeter setting are given in paragraphs 6.4.4.3 and 6.4.5.3, respectively.

The altimeter setting shall be separated from Remarks by a solidus "/" and a space. If there are no Remarks, the solidus following the altimeter setting shall be omitted.

The altimeter setting shall be entered in hundredths of inches of mercury using only the units, tenths, and hundredths digits (without a decimal point). For example, an altimeter setting of 30.13 inches shall be reported as 013.

9.7 Coding Remarks.

Remarks shall be included in all observations, if appropriate.

Remarks shall be separated from the altimeter setting with a solidus and a space.

There are six groups of remarks: Runway Visual Range (9.7.2), Operationally Significant Remarks (9.7.3), Special Notices (9.7.4), Other Coded Remarks (9.7.5), Additive Data (9.7.6), and Remarks Elaborating on Other Coded Data (9.7.7).

The entries shall be made in accordance with the following:

a. Where plain language is called for, authorized contractions, abbreviations, and symbols should be used to conserve time and space. However, in no case should an essential remark, of which the observer is aware, be omitted for the lack of readily available contractions. In such cases, the only requirement is that the remark be clear. For a detailed list of authorized contractions, see FAA Manual 7340 Series, *Contractions*. Selected authorized contractions, abbreviations, and symbols can be found in the various tables of this Handbook and in Appendix B.

b. Time entries shall be made in minutes past the hour if the time reported occurs during the same hour the observation is taken. Hours and minutes shall be used if the hour is different, or this Handbook prescribes the use of the hour and minutes, e.g., the time of the observation.

c. Location of phenomena within 10 miles of the station shall be reported as VCNTY. Phenomena between 10 miles and 30 miles of the station shall be reported by direction from the station. Phenomena beyond 30 miles shall be reported as DSNT, followed by the direction from the station.

d. Movement of clouds or weather shall be reported with respect to the direction toward which the phenomena is moving.

e. Directions shall use the eight points of the compass entered in a clockwise order.

9.7.1 Order of Remarks. Insofar as possible, remarks should be entered in the order they are presented in the following paragraphs.

9.7.2. Encoding Runway Visual Range. When reported, this remark shall be the first remark following the altimeter setting. The 10-minute runway visual range (RVR) values for the Designated RVR Runway shall be included in Record, Record Special, and Special observations. The values shall be based on light setting 5 and reported in increments of 200 feet to 3,000 feet and 500 feet above 3,000 feet. The format used shall be either **Rnn(d)**$VRV_cV_c(V_s)$ or, if the RVR has been variable during the 10-minute period, **Rnn(d)**$VRV_nV_n(V_s)VV_xV_x(V_s)$.

Designated military stations shall report 1-minute RVR data in 100's of feet based on the actual light setting as $RVRV_rV_r(V_s)$ or **Rnn(d)**$VRV_rV_r(V_s)/V_rV_r(V_s)$.

The meanings of the code figures are:

R	Indicates that the runway number follows.
nn	Runway number.
(d)	Runway number designator ("R" for right, "L" for left, and "C" for center).
VR	Indicates that visual range data follow.
V_cV_c	Constant reportable value in hundreds of feet of visual range for the past 10 minutes.
V_nV_n	Lowest reportable value in hundreds of feet of visual range for the past 10 minutes.
V	Separates lowest and highest visual range values.
V_xV_x	Highest reportable value in hundreds of feet of visual range for the past 10 minutes.

V_s Symbol "+" or "−" to indicate, respectively, that the preceding RVR value is the highest or lowest reportable value and that the RVR is above (+) or below (−) that value.

V_rV_r The RVR in hundreds of feet. If two values are reported, the first is the touchdown RVR, and the second is for the rollout RVR.

For example the 10-minute RVR for runway 01L, varying between 1,000 and 5,000 feet would be encoded R01LVR10V50.

If the RVR values cannot be obtained, report:

RVRNO (civil airports) to indicate that the appropriate RVR system is out of service. (Include this remark in all observations until the outage is reported in a NOTAM), or

(military airbases) to indicate that neither of the RVR values are available for the in-use runway.

RVRENO (civil airports) to indicate that the RVR system(s) is operational, but the 10-minute RVR values are not available for the SAO.

NO (military airbases) entered in place of appropriate V_rV_r values to indicate that either the touchdown or rollout RVR is not available for the in-use runway.

For example, R01LVRNO/50 would indicate that the touchdown RVR was not available but the rollout RVR was 5,000 feet.

9.7.3 Encoding Operationally Significant Remarks. This group of remarks shall be used to report all operationally significant information not included in the remarks elaborating on other encoded data. This group shall be separated from remarks (if any) preceding them with a solidus and a space, and from each other with a space. Weather conditions that are not reflected in the conditions reported in the body of the SAO shall be described using the notations in Table 9-8, contractions or plain language. Table 9-9 indicates the applicability of these remarks to the different types of stations. The table also indicates whether or not the data are included in Record (including Record Special) observations, and Special observations.

9.7.3.1 Weather and Obstructions to Vision. At designated augmented stations, manually observed weather and obstructions to vision are reported in accordance with agency procedures.

9.7.3.2 Surface-based Obscuring Phenomena. Whenever the reported sky condition includes a partial obscuration (−X), the phenomena producing the obscuration shall be indicated in Remarks using the appropriate notation from Table 9-8. The appropriate notation is followed by the tenths of sky hidden which is entered as a number without a decimal. An entry of RF3 would indicate that the -X reported in sky condition was caused by rain and fog obscuring 3/10 of the sky.

9.7.3.3 Variable Sky Condition. The remark shall identify the layer that is varying and indicate the range of variability (see paragraph 3.5.1.5). For example, SCT V BKN would identify a scattered layer that is variably broken. If there are several layers of the type being reported as variable, the variable layer shall be identified by including the layer height, e.g., 14 BKN V OVC.

Table 9-9. Operationally Significant Remarks

Element of SAO Report / Type of Station:	AO1		AO1A		AO2		AO2A		Manual	
Type of Observation:	SA	SP	SA	SP	SA	SP	SA	SP	SA	SP
Weather and Obstructions to Vision (9.7.3.1)			D	D						
Surface-based Obscuring Phenomena (9.7.3.2)									X	X
Variable Sky Condition (9.7.3.3)									X	X
Tornadic Activity (9.7.3.4)			X	X			X	X	X	X
Thunderstorms (9.7.3.5)			X	X			X	X	X	X
Hail (9.7.3.6)			X	X			X	X	X	X
Intermittent Precipitation (9.7.3.7)									X	X
Sector Visibility (9.7.3.8)									X	X
Significant Cloud Types (9.7.3.9)									X	X
Virga (9.7.3.10)			X	X			X	X	X	X
Sky Condition and Visibility not at Station (9.7.3.11)	D	D	D	D	D	D	D	D	X	X
Lightning (9.7.3.12)									X	X
Weather not at Station (9.7.3.13)									X	X
Obscuring Phenomena Aloft (9.7.3.14)									X	X
Pressure Unsteady (9.7.3.15)									X	X
Barogram V (9.7.3.16)									D	
Volcanic Ash (9.7.3.17)			X	X			X	X	X	X

X - Indicates elements included at all stations.
D - Indicates elements included only at designated stations.

9.7.3.4 Tornadic Activity. Whenever tornadoes, funnel clouds, or waterspouts begin, are in progress, or end, the event shall be described giving, insofar as is known, the phenomenon, the source of the information (if not the observer), the location and direction from the station, and the direction of movement (see paragraphs 9.7c and 9.7d). The time the tornado began shall be reported and prefixed with a "B"; the time the tornado ended shall be reported and prefixed with an "E." For example, TORNADO B13 NE MOVG E would indicate that a tornado, which began at 13 minutes after the hour, was between 10 and 30 miles northeast of the station, and was moving toward the east. The time(s) shall be omitted if the time(s) is(are) reported in the Remarks Elaborating on Other Coded Data (see paragraph 9.7.7).

9.7.3.5 Thunderstorms. Whenever thunderstorms begin (see paragraphs 5.4.2.1 and 5.5.2.1), are in progress, or end, the event shall be described giving, insofar as is known, the phenomenon, the location and the direction of movement (see paragraphs 9.7c and 9.7d.). In addition, the time the thunderstorm began shall be reported, prefixed with a "B" and the time the thunderstorm ended shall be prefixed with an "E." For example, a report of TB33 VCNTY STN MOVG E would indicate a thunderstorm, which began 33 minutes after the hour, is within 10 miles of the station, and is moving toward the east. A report of T MOVD E indicates a thunderstorm moved to the east. The time(s) shall be omitted if the time(s) is(are) reported in the Remarks Elaborating on Other Coded Data (see paragraph 9.7.7).

9.7.3.6 Hail. Whenever hail is detected, the beginning and ending time shall be reported, prefixed with a "B" or "E", as appropriate. The size of the largest hailstone shall be reported in 1/4 inch increments, identified with the contraction "HLSTO." If the size is less than 1/8 inch, encode the size as < 1/4. For example, AB17E40 HLSTO 3/4 would indicate that hail began at 17 minutes past the hour, ended at 40 minutes past the hour, and the largest hailstones were 3/4 inch in diameter. The time(s) shall be omitted if the time(s) is reported in the Remarks Elaborating on Other Coded Data (see paragraph 9.7.7).

9.7.3.7 Intermittent Precipitation. If the precipitation reported in the body of the SAO is intermittent, a remark consisting of the contraction "INTMT" followed by the type and intensity of the precipitation shall be included in the SAO. For example, if intermittent light rain is occurring at the time of the observation, INTMT R- would be included in the SAO. This remark is not included if the intermittent precipitation has been occurring but is not occurring at the time of the observation.

9.7.3.8 Sector Visibility. Whenever the sector visibility is less than 3 miles and differs from the prevailing visibility, the remark VSBY **ddvv** shall be entered where **dd** defines the sector to 8 points of the compass and **vv** is the sector visibility, using the appropriate set of values in Table 9-7 (see paragraphs 4.6.5.3 and 4.6.6.2), e.g, VSBY N2 would indicate that the visibility in the northern octant was 2 miles.

9.7.3.9 Significant Cloud Types. When the following clouds are observed, the indicated remark shall be entered in all observations:

- Cumulonimbus (for which no thunderstorm is being reported) -- enter the remark "CB," location (if known), direction from the station, and direction of movement (if known). An example is CB W MOVG E would indicate a CB between 10 and 30 miles west of the station and moving toward the east. If the cloud was more than 30 miles from the station the remark would be CB DSNT E.

- Towering cumulus -- enter the remark "TCU," the location (if known), and the direction from the station. For example, TCU W would indicate a towering cumulus cloud between 10 and 30 miles west of the station.

- Altocumulus castellanus -- enter the remark "ACC," and the direction from the station. For example, ACC NW would indicate altocumulus cloud 10 to 30 miles northwest of the station.

- Standing lenticular (stratocumulus, SCSL, altocumulus, ACSL, or cirrocumulus, CCSL), or rotor clouds -- enter a remark describing the cloud and the direction from the station, e.g., ACSL SW – W, APRNT ROTOR CLDS S, CCSL OMTS S.

9.7.3.10 Virga. When precipitation is observed to be falling from clouds but is not reaching the ground because of evaporation, report "VIRGA" and the direction from the station, e.g., VIRGA DSNT SW.

9.7.3.11 Sky Condition and Visibility Not at Station. When an automated station uses meteorological discontinuity sensors, remarks shall be added to identify site specific sky conditions or visibilities which differ from the reported prevailing conditions. The remark shall be of the form: element, value, location. For example, CIG 10 RY29 or VSBY 2 RY11. Remarks shall only be generated when the condition is lower than that reported in the body of the observation.

9.7.3.12 Lightning. When lightning is observed, the frequency and type of lightning and the location shall be reported in the format--(frequency) LTG (type) (location). If the location of the lighting is associated with a reported thunderstorm, the location shall be omitted. The contractions for the type and frequency shall be based on Table 9-10 and reported as follows:

- If the lightning is within 10 miles of the station, include the phrase "VCNTY STN" in the report, e.g., OCNL LTGCA VCNTY STN to report cloud-air lightning in the vicinity of the station, occurring less than once a minute.

- If the lightning is between 10 and 30 miles from the station, include the type and direction from the station in the report, e.g., FQT LTGCGCC NW to report frequent (1 to 6 flashes a minute) cloud-ground and cloud-cloud lightning 10 to 30 miles northwest of the station.

- If the lightning is beyond 30 miles from the station report "LTG DSNT" and the direction from the station with no reference to the frequency or type of lightning, e.g., LTG DSNT W.

9.7.3.13 Weather Not at the Station. When weather is observed but is not occurring at the station, report the type and intensity ("U" if intensity is not known), and the direction from the station. For example, RU N would indicate rain of unknown intensity was 10 to 30 miles north of the station.

9.7.3.14 Obscuring Phenomena Aloft. When the sky condition report includes a layer other than clouds, such as, smoke or haze, the type of phenomena in the layer plus the height and sky cover of the layer shall be reported. For example, K 20 BKN would indicate that the 2,000 foot broken layer reported in the sky condition was composed of smoke.

9.7.3.15 Pressure Unsteady. When the pressure is determined to be unsteady at the time of observation (see paragraph 6.6.2.1), the remark PRES UNSTDY shall be included in the observation.

Table 9-10. Type and Frequency of Lightning

Type of Lightning		
Type	**Contraction**	**Definition**
Cloud-ground	CG	Lightning occurring between cloud and ground.
In-cloud	IC	Lightning which takes place within the thunder cloud.
Cloud-cloud	CC	Streaks of lightning reaching from one cloud to another.
Cloud-air	CA	Streaks of lightning which pass from a cloud to the air, but do not strike the ground.
Frequency of Lightning		
Frequency	**Contraction**	**Definition**
Occasional	OCNL	Less than 1 flash/minute.
Frequent	FQT	About 1 to 6 flashes/minute.
Continuous	CONT	More than 6 flashes/minute.

9.7.3.16 Barogram V. When a barogram indicates a rapid fall and rise of pressure (see paragraph 6.6.2.2), the phrase "LOWEST PRES" followed by the lowest sea-level pressure in tens, units, and tenths of hectopascals, and the time (hours and minutes) of the lowest pressure shall be included in the observation. For example, a report of LOWEST PRES 631 2345 describes a pressure decreasing to 963.1 hectopascals at 2345 UTC and then increasing.

9.7.3.17 Volcanic Ash. When volcanic ash is observed, either aloft, or falling to the surface, and is not reported in the body of the SAO, a remark "VOLCANIC ASH" shall be included in the observation.

9.7.4 Encoding Special Notices. This group of remarks shall be used to further define the observation program at the station and provide other relevant information. This group shall be separated from remarks preceding them with a solidus and a space, and from each other with a space. Table 9-11 indicates the applicability of these remarks to the different types of stations. The table also indicates whether or not the data may be included in Record (including Record Special) observations and Special observations.

Table 9-11. Special Notices.

Element of SAO Report / Type of Observation:	Type of Station: A01 SA	A01 SP	A01A SA	A01A SP	A02 SA	A02 SP	A02A SA	A02A SP	Manual SA	Manual SP
No Specials Taken (9.7.4.1)									D	
Other Relevant Information (9.7.4.2)			D	D			D	D	D	D
First or Last Observations (9.7.4.3)									X	

X - Indicates elements included at all stations.
D - Indicates elements included only at designated stations.

9.7.4.1 No Specials Taken. At manual stations where Specials are not taken, the remark "NOSPL" shall indicate that no changes in weather conditions will be reported until the next scheduled observation.

9.7.4.2 Other Relevant Information. Agencies may add other information relevant to their operations, such as information on fog dispersal operations, runway conditions, etc.

9.7.4.3 Identification of First and Last Observations. At part-time stations, the first and last observations transmitted shall be identified by including the word "FIRST" in the first observation after a break in observational coverage, or "LAST" in the last observation before a break in observational coverage.

9.7.5 Encoding Other Coded Remarks. Table 9-12 indicates the applicability of these remarks to the different types of stations. The table also indicates whether or not the data may be included in Record (including Record Special) observations and Special observations.

Table 9-12. Encoding Other Coded Remarks

Element of SAO Report / Type of Observation:	Type of Station: A01 SA	A01 SP	A01A SA	A01A SP	A02 SA	A02 SP	A02A SA	A02A SP	Manual SA	Manual SP
Synoptic Cloud Types (9.7.5.1)									D	
Depth of Snow on Ground (9.7.5.3)									D	

D - Indicates elements included only at designated stations.

9.7.5.1 Synoptic Cloud Types $8/C_LC_MC_H$. This group shall be reported in 3- and 6-hourly observations at designated stations when clouds are observed. The predominant low cloud (C_L), middle cloud (C_M), and high cloud (C_H) shall be identified in accordance with the WMO *International Cloud Atlas*, Volumes I and II, or the WMO *Abridged International Cloud Atlas*.

A "0" shall be encoded for the low, middle, or high cloud type if no cloud is present in that classification. A solidus "/" shall be encoded for layers above an overcast. For example, a report of 8/6// would indicate an overcast layer of stratus clouds; a report of 8/903 would indicate cumulonimbus type low clouds, no middle clouds, and dense cirrus high clouds.

9.7.5.2 Depth of Snow on Ground, 4/sss. This group shall be included in the 0000 and 1200 UTC observation whenever there is more than a trace of snow on the ground. It shall be included in the 0600 and 1800 UTC observation if there is more than a trace of snow on the ground and more than a trace of precipitation (water equivalent) has occurred within the past 6 hours. The first two characters **4/** indicates the type of report, and precede the snow depth, **sss**, which shall be encoded in whole inches using three digits. For example, a snow depth of 21 inches shall be encoded as 4/021.

9.7.6 Encoding Additive Data Groups. This group of remarks shall be reported at designated stations. The group shall be separated from preceding remarks by a solidus "/" and a space. Table 9-13 indicates the applicability of these remarks to the different types of stations. The table also indicates whether or not the data may be included in Record (including Record Special) observations and Special observations.

Table 9-13. Additive Data Groups

Element of SAO Report / Type of Station:	AO1		AO1A		AO2		AO2A		Manual	
Type of Observation:	SA	SP	SA	SP	SA	SP	SA	SP	SA	SP
Pressure Tendency (9.7.6.1)	D		D		X		X		D	
Precipitation Amount (9.7.6.2)	D		D		X		X		D	
24-Hour Precipitation (9.7.6.3)	D		D		X		X		D	
Maximum Temperature (9.7.6.4)	D		D		X		X		D	
Minimum Temperature (9.7.6.5)	D		D		X		X		D	
24-Hour Max/Min Temperature (9.7.6.6)	D		D		X		X		D	

X - Indicates elements included at all stations.
D - Indicates elements included only at designated stations.

9.7.6.1 Pressure Tendency, 5appp. The **5appp** group shall be included in 3- and 6-hourly observations (see paragraph 6.4.5.4). In the group, the **5** identifies the pressure tendency group; the **a** represents the character of pressure change over the past 3 hours; and **ppp** is the change in pressure in the past 3 hours (see paragraph 6.4.4.5). The character **a** shall be encoded by selecting the code figure from Table 9-14 that best describes the pressure change in the past 3 hours. The **ppp** shall be encoded based on the absolute value of the change of either the station pressure or the altimeter setting in the past 3 hours encoded in tenths of hectopascals and using the tens, units, and tenths digits, e.g., a steady increase of 3.2 hectopascals in the past three hours would be encoded 52032.

Table 9-14. Characteristic of Barometer Tendency

Primary Requirement	Description	Code Figure
Atmospheric pressure now higher than 3 hours ago.	Increasing, then decreasing.	0
	Increasing, then steady, or increasing then increasing more slowly.	1
	Increasing steadily or unsteadily.	2
	Decreasing or steady, then increasing; or increasing then increasing more rapidly.	3
Atmospheric pressure now same as 3 hours ago.	Increasing, then decreasing.	0
	Steady.	4
	Decreasing, then increasing.	5
Atmospheric pressure now lower than 3 hours ago.	Decreasing, then increasing.	5
	Decreasing then steady; or decreasing then decreasing more slowly.	6
	Decreasing steadily or unsteadily.	7
	Steady or increasing, then decreasing; or decreasing then decreasing more rapidly.	8

9.7.6.2 <u>**Precipitation Amount, 6RRR/.**</u> The **6RRR/** group shall be included in the 3- and 6-hourly observations whenever precipitation has occurred since the previous 3- or 6-hourly observation. In the group, the **6** identifies the precipitation amount group in the observation, the **RRR** is the amount of precipitation (see paragraphs 5.3.4.3 and 5.3.4.7), and the / indicates the end of the group. The amount of precipitation (liquid equivalent) accumulated in the past 3 hours shall be reported in the 3-hourly observation and the amount accumulated in the past 6 hours shall be reported in the 6-hourly observation. The amount, **RRR**, shall be encoded in inches, using the units, tenths and hundredths digits of the amount. An example is 2.17 inches of precipitation would be encoded 6217/. When the amount exceeds 9.99 inches, the whole inches shall be reported in plain language immediately following the **6RRR/** group and the tenths and hundredths of an inch shall be encoded for RRR in the group. For example, 11.04 inches of precipitation would be encoded 6004/ ELEVEN. A trace shall be encoded 6000/. When an indeterminable amount of precipitation has occurred during the period, **RRR** shall be encoded 6////.

9.7.6.3 24-Hour Precipitation, $7R_{24}R_{24}R_{24}R_{24}$. This group shall be included in the 1200 UTC (or other agency designated time) observation whenever more than a trace of precipitation (liquid equivalent) has fallen in the preceding 24 hours.

The amount of precipitation $R_{24}R_{24}R_{24}R_{24}$ shall be encoded by using the tens, units, tenths, and hundredths of inches (liquid equivalent) for the 24-hour period. If more than a trace (liquid equivalent) has occurred and the amount cannot be determined, the report shall be encoded 7////. For example, 1.25 inches of precipitation (liquid equivalent) in the past 24 hours shall be encoded 70125.

9.7.6.4 Maximum Temperature, $1s_nT_xT_xT_x$. The $1s_nT_xT_xT_x$ group for maximum temperature (see paragraph 7.3.4) shall be reported in 6-hourly observations (see paragraph 7.4.2.2). In the group, the 1 identifies the maximum temperature group; the s_n, the sign of the data, shall be encoded as "1" if the maximum temperature is below 0 degrees Fahrenheit and "0" if the maximum temperature is 0 degrees Fahrenheit or higher. The $T_xT_xT_x$ shall be the maximum temperature during the past 6 hours encoded in degrees Fahrenheit using three digits--a temperature of 1 degree Fahrenheit shall be encoded 001, a temperature of 10 degrees Fahrenheit shall be encoded 010, and a temperature of 100 degrees Fahrenheit shall be encoded 100. A maximum temperature of −21 degrees Fahrenheit shall be encoded 11021. A maximum temperature of 112 degrees Fahrenheit shall be encoded 10112.

9.7.6.5 Minimum Temperature, $2s_nT_nT_nT_n$. The $2s_nT_nT_nT_n$ group for minimum temperature (see paragraph 7.3.4) shall be included in 6-hourly observations (see paragraph 7.4.2.2). In the group, the 2 identifies the minimum temperature group; the s_n, the sign of the data, shall be encoded as "1" if the minimum temperature is below 0 degrees Fahrenheit and "0" if the minimum temperature is 0 degrees Fahrenheit or higher. The $T_nT_nT_n$ shall be the minimum temperature in the past 6 hours encoded in degrees Fahrenheit using three digits (see paragraph 9.7.6.4). For example, a minimum temperature of −21 degrees Fahrenheit shall be encoded 21021. A minimum temperature of 12 degrees Fahrenheit shall be encoded 20012.

9.7.6.6 24-Hour Maximum and Minimum Temperature, $4s_nT_xT_xT_xs_nT_nT_nT_n$. The 24-hour maximum temperature, $T_xT_xT_x$, and the 24-hour minimum temperature $T_nT_nT_n$, shall be reported at midnight LST (see paragraphs 7.3.4 and 7.4.2.2). $T_xT_xT_x$ and $T_nT_nT_n$ shall be encoded in degrees Fahrenheit using three digits (see paragraph 9.7.6.4). s_n the sign of the data, shall be encoded as "1" if the temperature is below 0 degrees Fahrenheit and "0" if the temperature is 0 degrees Fahrenheit or higher. For example, a 24-hour maximum temperature of 10 degrees Fahrenheit and a 24-hour minimum temperature of −15 degrees Fahrenheit shall be encoded 400101015. A 24-hour maximum temperature of 112 degrees Fahrenheit and a 24-hour minimum temperature of 84 degrees Fahrenheit shall be encoded as 401120084.

9.7.7 Encoding Remarks Elaborating on Other Coded Data. This group of remarks shall be used to define elements that were reported variable in the body of the report and to report additional data required to amplify data reported elsewhere in the SAO. Table 9-15 indicates the applicability of these remarks to the different types of stations. The table also indicates whether or not the data are included in Record (including Record Special) observations and Special observations.

Table 9-15. Remarks Elaborating on Coded Elements

Element of SAO Report	Type of Station:	A01		A01A		A02		A02A		Manual	
	Type of Observation:	SA	SP	SA	SP	SA	SP	SA	SP	SA	SP
Variable Ceiling (9.7.7.1)		X	X	X	X	X	X	X	X	X	X
Tower/Surface Visibility (9.7.7.2)				D	D			D	D	D	D
Variable Surface Visibility (9.7.7.3)		X	X	X	X	X	X	X	X	X	X
Time of Beginning/Ending of Weather (9.7.7.4)		D		D		X		X		D	
Hourly Precipitation Amount (9.7.7.5)		D		D		X		X		D	
Wind Shift (9.7.7.6)		X	X	X	X	X	X	X	X	X	X
Variable Wind Direction (9.7.7.7)		X	X	X	X	X	X	X	X	X	X
Peak Wind (9.7.7.8)		X		X		X		X		X	
Pressure Rising/Falling Rapidly (9.7.7.9)		X	X	X	X	X	X	X	X	X	X

X - Indicates elements included at all stations.
D - Indicates elements included only at designated stations.

9.7.7.1 Variable Ceiling. Whenever the ceiling is below 3,000 feet and reported variable (see paragraph 3.3.5.7), the remark CIG **minVmax** shall be entered where **min** is the lowest ceiling height evaluated and **max** is the highest ceiling height evaluated. For example, CIG 5V10 would indicate a ceiling that was varying between 500 and 1,000 feet.

9.7.7.2 Tower/Surface Visibility. If tower or surface is carried in the remarks, use the appropriate set of values listed in Table 9-7 (see paragraph 4.4.4) and precede the visibility value with the appropriate identifier, TWR or SFC, as required. For example, TWR VSBY 1 would indicate the visibility from the control tower was 1 mile.

9.7.7.3 Variable Surface Visibility. Whenever the surface visibility is less than 3 miles and is variable (see paragraph 4.4.3), the remark VSBY **minVmax** shall be entered where **min** is the lowest visibility evaluated and **max** is the highest visibility evaluated (using the appropriate set of values listed in Table 9-7). For example, a visibility that was varying between 1/2 and 2 miles would be encoded VSBY 1/2V2.

9.7.7.4 Reporting the Beginning and Ending Time of Weather. When weather begins or ends, the report shall include the type of weather, the beginning and/or ending time (prefixed with a "B" and/or "E"), (see paragraph 5.3.4.6) and shall be reported in the next Record or Record Special observation unless it has been reported under **Operationally Significant Remarks** (see paragraphs 9.7.3.4, 9.7.3.5, and 9.7.3.6). For example, if rain began at 0005, ended at 0030, and snow began at 0020, and ended at 0055, the remarks would be encoded RB05E30SB20E55.

9.7.7.5 Hourly Precipitation Amount. This remark shall be included in Record and Record Special observations only. The format shall be either P **rrr** (AO1/AO1A) or PCPN **rrrr** (AO2/AO2A), where **rrr** or **rrrr** is the liquid-equivalent of all precipitation that has occurred since the last hour (see paragraphs 5.3.4.7, 5.4.3.2, and 5.5.4.1). The amount shall be encoded in hundredths of an inch. For example, PCPN 0009 would indicate 9/100 of an inch of precipitation fell in the past hour; P 000 would indicate that less than 1/100 of an inch of precipitation fell in the past hour.

The group shall be omitted if no precipitation occurred since the last hour.

9.7.7.6 Wind Shift. When a wind shift occurs (see paragraphs 8.4.7 and 8.5.5), "WSHFT" followed by a space and the time the wind shift began shall be entered (with only the minutes reported, if the hour can be inferred from the time of the observation). The contraction "FROPA" may be entered following the time if it is reasonably certain that the wind shift was the result of a frontal passage. For example, a remark reporting a wind shift accompanied by a frontal passage at 30 minutes after the hour would be encoded WSHFT 30 FROPA.

9.7.7.7 Variable Wind Direction. Whenever the wind direction is variable (see paragraph 8.4.3) and the speed is greater than 10 knots, the remark WND **ddVdd** shall be entered where **dd** defines the range of variability. An example is a wind varying between 30 degrees and 120 degrees would be encoded as WND 03V12.

9.7.7.8 Peak Wind. Whenever the peak wind exceeds 25 knots, the remark PK WND **ddff/tt** shall be entered in the next Record observation (see paragraphs 8.4.6 and 8.5.5) where **dd** is the direction of the peak wind, **ff** is the peak wind speed since the last Record observation, and **tt** is the time of occurrence (with only the minutes reported if the hour can be inferred from the observation time). For example, a peak wind of 45 knots from 280 degrees that occurred at 15 minutes past the hour would be encoded PK WND 2845/15.

9.7.7.9 Pressure Rising/Falling Rapidly. When the pressure is rising or falling rapidly at the time of observation (see paragraphs 6.4.4.5 and 6.4.5.4), the remark PRESRR (pressure rising rapidly) or PRESFR (pressure falling rapidly) shall be included in the observation.

9.8 Dissemination.

In this Handbook, dissemination is the act of delivering a completed observation to users.

9.8.1 Types of Dissemination. There are two general types of dissemination. These are:

- Long-line. The transmission of a weather report to a group of users on a regional or national scale.
- Local. The transmission or delivery of a weather report to individual or groups of users in the service area of the weather station.

9.8.2 Dissemination Requirements. All observations shall be given local dissemination. At designated stations, observations shall be given long-line dissemination. When observations are corrected, the corrected observations shall be given the same dissemination as the observation being corrected.

9.8.3 Dissemination Priority. All observations should be disseminated first to the local airport traffic control users. Further dissemination priorities shall be defined by the responsible agencies.

9.8.4 Corrections to Transmitted Data. Corrections shall be disseminated, as soon as possible, whenever an error is detected in a transmitted report. However, if the erroneous data has been corrected or superseded by a later report (with the same or more complete dissemination), it shall not be necessary to transmit the corrected observation. Corrections transmitted shall consist of the entire corrected observation. The original time of the observation shall be used as the time of observation in the corrected report.

9.9 Observation Filing Time

Special observations shall be completed and transmitted, as soon as possible. Agencies shall establish filing deadlines for scheduled observations; such filing deadlines shall be no sooner than necessary to assure the availability of the observation at its scheduled time of observation. Scheduled observations shall not be transmitted more than 10 minutes before their scheduled time.

9.10 Delayed Reports

When an observation is taken on time but transmission is delayed, the observation may be identified as a Routine Delayed observation using "RTD" for the type of observation.

When transmission of an observation is delayed until time for the next Record or Record Special observation, only the latest observation shall be transmitted. In the log, the remark **(FIBI)** shall be appended in parentheses to the observation that was not transmitted to indicate the observation was not transmitted. The remark "FIBI" shall not be included in any local dissemination of the observation.

When a Special observation is not transmitted long-line, later Specials shall be transmitted long-line only when the overall change between the last transmitted report and the current report satisfies the criteria for a Special observation. If the Special is not transmitted long-line, the remark "FIBI" shall be appended in the log to the current report. The Special shall be disseminated locally.

Reports of Volcanic Eruption shall be disseminated regardless of the delay. Any reasonable means shall be used to disseminate the report.

9.11 Voice Dissemination at Automated Stations.

Designated automated stations shall provide voice dissemination of surface weather information. Individual agencies shall provide detailed operating procedures for voice dissemination of this information from these stations.

CHAPTER 10

CERTIFICATION AND QUALITY CONTROL

10.1 General.

This chapter prescribes the general standards for quality control of meteorological observations. It separately addresses the standards and procedures applicable to all stations. It also discusses the requirement for quality control at National Centers.

10.2 General Quality Control Requirements.

10.2.1 Certification of Observers. Agencies shall have an observer certification program, and only observers certified through that program shall be authorized to take SAO observations. The NWS shall have the responsibility for certifying observers at civil stations.

The certification of the observer shall attest to the fact that in the view of the certifying agency the observer has:

- **Acceptable vision**

  The observer shall have distant vision of at least 20/30 (Snellen) in at least one eye, corrected if necessary, and shall have near vision, corrected if necessary, that meets the Jaeger #2 standard.

- **Adequate Training**

  The level of training would be commensurate with the level of the observing function to be undertaken by the candidate.

- **Demonstrated Ability to Take Required Observations**

  This demonstration would be dependent on the level of the observing function to be undertaken by the candidate.

10.2.2 Approval of Stations. All weather observing stations where SAOs are taken shall be approved by the responsible agency. The procedures for the approval shall also be established by that agency. The procedures shall include verification that:

- the instruments to be used meet the minimum standards for accuracy, range, and resolution for weather elements as prescribed in this document;

- all automated observing systems use the approved algorithms given in the *Federal Standard Algorithms for Automated Weather Observing Systems Used for Aviation Purposes*;

- the installation of the associated sensors satisfy the siting requirements prescribed in the *Federal Standard for Siting Meteorological Sensors at Airports*;

- the proposed maintenance program to support the operation of the station is acceptable to the responsible agency; and

- all observers are certified at a level commensurate with their duties in accordance with this Handbook.

10.2.3 Quality Control of Observing Programs. Each agency shall establish an inspection program to ensure that their surface observing stations utilize proper procedures. The primary objective of the inspections shall be to ascertain that:

- the siting and exposure of instruments is the best practical, and are still within acceptable limits;

- instruments are in good order and have been compared to the standard sensors, as required;

- standard procedures are being used to generate observations at the station;

- the observation program at the station satisfies the requirements for observations at that location; and

- any observers augmenting automated observations or taking manual observations are certified.

10.2.4 Quality Control of Instruments and Sensors.

10.2.4.1 Comparison of Portable Transfer-Standard Sensors. Agencies shall establish a procedure to routinely compare portable transfer-standard sensors and instruments, which are used during station inspections, to standards that ensure compliance with the accuracy requirements in this Handbook.

10.2.4.2 Comparison of Instruments and Sensors. Agencies shall establish a procedure to periodically compare the instruments and sensors used at operational observing stations to standards that ensure compliance with the accuracy requirements in this Handbook.

10.2.4.3 Calibration and Standardization of Sensors. Agencies shall establish procedures to calibrate and standardize sensors. Calibration and standardization shall be performed at least annually, after installation, and after any major maintenance is performed on a sensor.

10.2.5 Quality Control of Observations.

10.2.5.1 Pre-Dissemination Quality Control. The quality control performed at surface weather observing stations prior to any dissemination of the weather report is the most important of all quality control operations. Once an erroneous message has been given to users, it is impossible to ensure that corrections are received by that same group of users. Therefore, all operational weather observing stations shall have as high a level of pre-dissemination quality control procedures as practicable.

10.2.5.2 Post-Dissemination Quality Control. All surface weather observations shall be checked at the site for errors after dissemination and prior to the next observation. If possible, the disseminated observation shall be compared with the original observation to verify that no errors were generated during the dissemination process.

10.3 Quality Control Performed at Automated Stations.

These standards apply to all Federally procured and implemented automated surface weather observing systems designed, installed, and operated as part of the Surface Aviation Observation program. While these standards do not apply to older systems, which may continue to operate until replaced or modified, these standards are recommended should those older automated systems require modification.

10.3.1 Routine Maintenance at Automated Stations. Each agency shall establish a schedule of maintenance for their automated systems. The schedule shall be verified as part of the certification and inspection process.

10.3.2 Data Quality Checks at Automated Stations. All automated systems shall have as high a level of reliability as practicable. The systems should use data quality checks written into the *Federal Standard Algorithms for Automated Weather Observing Systems Used for Aviation Purposes* to avoid dissemination of erroneous data.

10.3.3 Verification of Observation Report Transmitted at Automated Stations. Systems shall have a verification procedure to check that transmitted reports were received at their initial point of distribution from the system without the introduction of random transmission errors.

10.4 Quality Control at Manual Stations.

10.4.1 Report and Record Checking at Manual Stations. Each agency shall establish a near real-time quality control program for all manual stations. This program shall be used to quickly detect repetitious errors being made by observers at the station. The program may use station personnel or personnel at another location with access to the records and reports made at the manual station.

10.4.2 Routine Maintenance at Manual Stations. Each agency shall establish a schedule of maintenance for equipment at manual stations. Unless relieved of the responsibility, observers at manual stations shall determine the operational acceptability of meteorological equipment consistent with agency policy. In addition to having the responsibility for the operational status of observing equipment, the observer shall also have the final authority for deciding the operational status of any meteorological equipment used in the observing program.

10.4.3 Data Quality Checks at Manual Stations. Insofar as possible, all observations made at manual stations should be checked for errors and internal consistency prior to local and long-line dissemination. This check should consist of recalculating computed data, verifying the syntax of the recorded observations, and comparing the recorded observations against the reports recorded on any local dissemination devices.

10.4.4 Verification of Observation Report at Manual Stations. If possible, transmitted observations shall be verified against the original recorded observation and, if appropriate, action shall be taken to correct any discrepancies found.

10.5 Quality Control at Augmented Stations.

10.5.1 Routine Maintenance at Augmented Stations. Standards shall be consistent with paragraph 10.3.1 for the automated surface weather observing systems operated at these stations and shall be consistent with the standards in paragraph 10.4.2 for those aspects of the observing function that are manual.

10.5.2 Data Quality Checks at Augmented Stations. The data quality checks in paragraph 10.3.2 are applicable to automated systems at these stations. Manual entries should be checked for errors and internal consistency prior to local and long-line dissemination.

10.5.3 Verification of Observation Report Transmitted at Augmented Stations. A verification procedure shall be established to check that transmitted reports were received at their initial point of distribution without transmission errors. If possible, transmitted observations shall be verified against the original recorded observation and, if appropriate, action shall be taken to correct any discrepancies found.

It is recommended that the system used for entering observer data and remarks into the automated observation have quality control checks built into the system. The system should verify that the entries have the correct syntax, verify that the entries are within expected limits for the element, and prompt the operator for any required remarks.

10.5.4 Quality Control of Augmentation. Agencies shall establish a procedure at all augmented stations to check the manual entries in the automated observations.

10.6 Quality Control Performed at Central Locations

Insofar as possible, all agencies should implement quality control checking at a central location on a near real-time basis. Agencies shall devise a method to provide feedback to the responsible maintenance center in the case of errors in the automated observation, or to the observer or supervising station in the case of errors detected in manual observations.

10.7 User Feedback

Agencies shall encourage users to comment on the performance of their observing programs. In this context, users are anyone utilizing the data from the programs.

It is recommended that all public issuances of information on the observing systems include an address of the office designated to process user feedback.

CHAPTER 11

OBSERVATIONAL RECORDS

11.1 General

This chapter prescribes the minimum standards for maintaining a record of the operational status of weather observing stations and maintaining records of surface weather observations. Because of the lasting value of all the data collected in the surface observations program, agencies are encouraged to devise methods to store as much of the data as possible within their physical and financial constraints. Because of the generally common interest in historical and archived data, agencies should provide observations to the National Climatic Data Center (NCDC).

11.2 Types of Records.

11.2.1 Station Information File

Each agency shall establish a Station Information File for each station under their jurisdiction. The file shall be a record of characteristics of each station. Table 11-1 presents a list of data required from most stations. Copies of all Station Information Files shall be available upon request from the responsible agency when needed to interpret weather records from a particular station.

Table 11-1. Content of Station Information File

Physical Characteristics		
Station Name	Latitude/Longitude	Type of Station
Airport Name	Ground Elevation	Description of Significant Topography
Station Identifier	Station Elevation	
WMO Index Number	Climatological Elevation	
Time Zone		
Observation Schedule		
Types of Observations	Schedule for Observations	Hours of Operation
Observation Program		
Elements Observed	Special Criteria Transmitted (Y/N)	
Long-Line Communications Circuits		
Sensor Data		
Types of Sensors	Location of Sensors	Non-standard sensor siting

11.2.1.1 Station Information File at NCDC. A copy of the file for each station shall be sent to the agency group representatives (NOAA, U.S. Navy, and U.S. Air Force) at the Federal Climate Complex, Asheville, NC), and made available to the NCDC or under arrangement directly to the Federal Records Center, NCDC. A copy of the file shall be sent when a station is established, when any data listed in Table 11-1 or in the file changes, and when a station closes. This file shall become a part of that station's archived record.

11.2.1.2 Maintenance of Station Information File. Agencies shall establish procedures to ensure the validity of their stations' Station Information Files. It is recommended that the content of the most recent file be reviewed as part of each station inspection.

11.2.2 Observation Records. Each agency shall define a procedure for recording all SAOs intended for either local or long-line dissemination. The record shall also document changes in the configuration of the station's observation systems or sensors. Agencies shall arrange for the retention of these data according to the type of records storage addressed below.

11.3 Types of Records Storage

There are three types of storage addressed in this chapter: short-term storage, long-term retention, and archive. These are defined below:

- **Short-term Storage**

  storage of observations and records for 4 or more days, intended primarily to assist in sensor/system maintenance and verification of sensor/system records in the event of an Aircraft Mishap.

- **Long-term Retention**

  retention of observations and records for 5 years, intended to satisfy requirements for local studies and to support litigation.

- **Archive**

  observations and records permanently stored to establish a climatological record for the United States.

11.4 Automated and Augmented Station Observations and Records

11.4.1 Short-term Storage of Automated and Augmented Station Observations and Records. All automated stations located at airports, or broadcasting observations directly to pilots, shall maintain observations and records that would allow reconstruction of the observation disseminated to users.

11.4.2 Long-term Retention of Automated and Augmented Station Observations and Records. All observations and records that indicate the operational status of the automated system and sensors should be placed in long-term retention.

11.4.3 Archiving of Automated and Augmented Station Observations and Records. The DOC is responsible for archiving observations and records at the official Federal Records Center, as necessary, to satisfy requirements to monitor the Nation's climate. Agencies should include procedures to ensure the delivery of observations and station records.

11.5 Manual Station Records

11.5.1 Short-term Storage of Manual Station Records. Agencies shall maintain copies of all appropriate forms, recorder records, and other autographic records related to the observation program for a minimum of 4 days.

11.5.2 Long-term Retention of Manual Station Records. Each agency shall establish procedures to provide long-term retention of all disseminated SAOs and changes in sensor status.

11.5.3 Archiving of Manual Station Records. The DOC is responsible for archiving observations and records, as necessary, to satisfy requirements to monitor the Nation's climate. Agencies should include procedures to ensure the delivery of observations and station records.

APPENDIX A

GLOSSARY*

*The terms and definitions presented in this glossary are in accordance with their usage in this Handbook.

3-hourly observation. A record observation taken at 0300, 0900, 1500, or 2100 UTC.

6-hourly observation. A record observation taken at 0000, 0600, 1200, or 1800 UTC.

actual time of observation. For scheduled observations, it is the time the last element of the observation is observed or evaluated. For special observations, it is either the time the criteria for a Special was met, or the time the last element of the observation was observed or evaluated.

additive data. A group of coded remarks that includes pressure tendency, amount of precipitation, and maximum and minimum temperature during specified periods of time.

aircraft mishap. An inclusive term to denote the occurrence of an aircraft accident or incident.

algorithm. A set of rules implemented (usually in a computer) to process data and generate defined outputs.

altimeter setting. That pressure value to which an aircraft altimeter scale is set so that it will indicate the altitude above mean sea-level of an aircraft on the ground at the location for which the value was determined.

archive. A permanent record of surface weather observations and related data used to establish a climatological record for the United States.

atmospheric pressure. The pressure exerted by the atmosphere at a given point (see altimeter setting, pressure, sea-level pressure, station pressure).

augmentation. The act of adding data that is beyond the capability of an automated system to the automated surface weather observation.

augmented station. A weather observing station with an automated surface weather observing system that prepares the SAO for transmission, but with certified weather observers capable of adding information to the observation.

automated station. A weather observing station with an automated surface weather observing systems that prepares the SAO for transmission, but with no certified weather observers.

backup. An alternate method for providing an observation or documentation/communication of a weather element when the primary method is unavailable.

barogram. An analog record of pressure produced by a barograph.

barogram V (also termed pressure V). A fall in pressure at the rate of 0.06 inch or more per hour, followed by an abrupt rise in pressure at the rate of 0.06 inch or more per hour, with rise and fall each equaling 0.03 inch or more.

barograph. A recording barometer.

barometer. An instrument that measures atmospheric pressure.

barometric pressure. The actual pressure value indicated by a pressure sensor.

blowing dust. (manual) Dust raised by the wind to moderate heights above the ground, reducing the reported horizontal visibility to less than 7 miles.

blowing sand. (manual) Sand particles raised by the wind to moderate heights above the ground, reducing the reported horizontal visibility to less than 7 miles.

blowing snow. (manual) Snow particles raised from the ground by a strong, turbulent wind, reducing the reported horizontal visibility to less than 7 miles.

blowing spray. (manual) Water droplets torn by the wind from a body of water, generally from the crests of waves, and carried up into the air in such quantities that it reduces the reported horizontal visibility to less than 7 miles.

body of report. That portion of a surface aviation observation beginning with the station identifier and ending with the altimeter setting.

broken layer. Civilian: A layer whose summation amount of sky cover is 0.6 to 0.9. Military: A layer whose summation amount of sky cover is 0.6 to 0.9, or more than 0.9, but less than 1.0.

calm. A condition when no motion of the air is detected.

candela. A unit of luminous intensity, equal to 1/60 of the luminous intensity of a square centimeter of a black body heated to 1773.5 degrees Celsius.

ceiling. The height above the earth's surface (field elevation or ground elevation) of the lowest layer of clouds or obscuring phenomena aloft that is reported as broken, overcast, and is not classified "thin," or a surface-based obscuration not classified as "partial," and is detectable from the point of observation.

ceiling designator. A letter (M, E, or W) placed before the ceiling height which indicates the method used to determine the reported height.

ceiling light. A type of cloud-height indicator that uses a focused light to project vertically a narrow beam of light onto a cloud base.

ceilometer. A device used to evaluate the height of clouds and obscuring phenomena aloft or the vertical visibility into a surface-based obscuration.

certified observer. An individual approved by designated Federal agencies to take surface weather observations approved for use in aircraft operations.

clear sky. Civilian: The state of the sky when it is either cloudless or sky cover is less than 0.1. Military: The state of the sky when the sky cover is 0.

cloud. A visible aggregate of minute water droplets or ice particles in the atmosphere above the Earth's surface.

cloud-air lightning (CA). Streaks of lightning which pass from a cloud to the air, but do not strike the ground.

cloud-cloud lightning (CC). Streaks of lightning reaching from one cloud to another.

cloud-ground lightning (CG): Lightning occurring between cloud and ground.

cloud height. The height of the base of a cloud or cloud layer above the surface of the earth.

cloud layer. An array of clouds or obscuring phenomena aloft whose bases are at approximately the same level.

cloud movement. The direction toward which a cloud is moving when reported in an SAO.

cloud type. A cloud form which is identified according to the WMO International Cloud Atlas.

contraction. A shortened form of a word, title, or phrase used for brevity.

Coordinated Universal Time (UTC). The time in the zero degree meridian time zone.

cumulus. A principal cloud type in the form of individual, detached elements which are generally dense and possess sharp non-fibrous outlines.

cumulonimbus. An exceptionally dense and vertically developed cloud, occurring either isolated or as a line or wall of clouds with separated upper portions. These clouds appear as mountains or huge towers, at least a part of the upper portions of which are usually smooth, fibrous, or striated, and almost flattened.

designated RVR runway. A runway at civilian airports designated by the FAA for reporting RVR in long-line transmissions.

designated stations. Weather observing stations that have been instructed by their responsible agency to perform a specified task that is not required by standards to be performed at all stations.

dew point. The temperature to which a given parcel of air must be cooled at constant pressure and constant water-vapor content in order for saturation to occur.

dissemination. The act of delivering a completed observation to users.

drizzle. (manual) Fairly uniform precipitation composed exclusively of fine drops (diameter less than 0.02 inch or 0.5 mm) very close together.

duration of sunshine. The amount of time sunlight was detected occurring at a given point.

dust. (manual) Fine particles of earth or other matter raised or suspended in the air by the wind that may have occurred at or far away from the station.

element. One of the basic conditions of the atmosphere discussed in this FMH (sky condition, visibility, weather, obstructions to vision, pressure, temperature, dew point, and wind). See parameter.

estimated ceiling (E). The height of a layer aloft classified as a ceiling that was not determined by a method that qualifies as "measured."

field elevation. The elevation above sea level of the highest point on any of the runways of the airport.

filing time. The time a weather observation is first transmitted long-line or delivered to communication personnel.

fog. (automated) A visible aggregate of minute water particles (droplets) which are based at the Earth's surface and reduce horizontal visibility.

fog. (manual) A visible aggregate of minute water particles (droplets) which are based at the Earth's surface, with a depth of greater than approximately 20 feet, that reduces horizontal and vertical visibility.

freezing drizzle. (manual) Drizzle that freezes upon impact with the ground, or other exposed objects.

freezing precipitation. Any form of precipitation that freezes upon impact and forms a glaze on the ground or exposed objects.

freezing rain. Rain that freezes upon impact and forms a glaze on the ground or exposed objects.

frozen precipitation. Any form of precipitation that reaches the ground in solid form (snow, ice pellets, hail).

funnel cloud. (augmented and manual) A violent rotating column of air, usually appended to a cumulonimbus cloud. A funnel cloud that does not reach the ground is reported as a FUNNEL CLOUD (see tornado and waterspout).

glaze. Ice formed by freezing precipitation covering the ground or exposed objects.

ground elevation. The official height of a weather station above sea-level when a field elevation has not been established. It is the height of the ground at the base of the ceilometer.

ground fog. (manual) Fog that has little vertical extent (normally less than 20 feet), and reduces visibility horizontally, but to a lesser extent vertically. The stars may often be seen by night and the sun by day.

gust. Rapid fluctuations in wind speed with a variation of 10 knots or more between peaks and lulls.

hail. (augmented and manual) Precipitation in the form of small balls or other pieces of ice falling separately or frozen together in irregular lumps.

haze. (automated) Fine particles of dust, salt, combustion products, or pollution products that are suspended in the atmosphere diminishing visibility (distinguished from fog by its dryness).

haze. (manual) A suspension in the air of extremely small, dry particles invisible to the naked eye and sufficiently numerous to give the air an opalescent appearance.

hectopascal. A unit of measure of atmospheric pressure equal to 100 newtons per square meter. It is the numerical equivalent of a millibar.

horizon. The actual lower boundary of the observed sky or the upper outline of terrestrial objects, including nearby natural obstructions. It is the distant line along which the earth, or the water surface at sea, and the sky appear to meet.

ice crystals. (manual) A fall of unbranched (snow crystals are branched) ice crystals in the form of needles, columns, or plates.

ice fog. (manual) A suspension of numerous minute ice crystals in the air, based at the Earth's surface, which reduces horizontal visibility.

ice pellets. (manual) Precipitation of transparent or translucent pellets of ice, which are round or irregular, rarely conical, and which have a diameter of 0.2 inch (5 mm), or less. There are two main types:

a. Hard grains of ice consisting of frozen raindrops, or largely melted and refrozen snowflakes.

b. Pellets of snow encased in a thin layer of ice which have formed from the freezing, either of droplets intercepted by the pellets, or of water resulting from the partial melting of the pellets.

ice pellet showers. (manual) Precipitation of ice pellets that abruptly changes intensity, or abruptly starts and stops.

in-cloud lightning (IC). Lightning which takes place within the thunder cloud.

indefinite ceiling (W). The vertical visibility into a surface-based obscuration.

layer. An array of clouds or obscuring phenomena aloft whose bases are at approximately the same level.

layer amount. The amount of sky covered by clouds or obscuring phenomena at a given level.

layer height. The height of the layer's base above the surface.

layer opacity. The degree of transparency of clouds or obscuring phenomena aloft.

lightning. The luminous phenomenon accompanying a sudden electrical discharge (see cloud-air lightning, cloud-cloud lightning, cloud-ground lightning and in-cloud lightning).

liquid equivalent. The water content of solid precipitation that fell during a specified period. It may or may not have accumulated on the surface of the ground.

liquid precipitation. Any form of precipitation that does not fall as frozen precipitation and does not freeze upon impact.

local dissemination. The transmission or delivery of a weather report to individuals or groups of users near the weather station.

Local Standard Time (LST): A time based on the geographic location of the station in one of the legally established time zones of the globe.

long-line dissemination (also long-line transmission). The transmission of a weather report by a communication media to a group of users on a regional or national scale.

long-term retention. Retention of data for 5 years to satisfy requirements for local studies and to support litigation.

manual station. A station, with or without an automated surface weather observing system, where the certified observers are totally responsible for all SAOs that are transmitted.

maximum temperature. The highest temperature during a specified period.

may. A term used to indicate that a procedure or practice is optional.

measured ceiling (M). A ceiling height for a layer aloft determined by a ceilometer operating within its operational range, a ceiling light when the measured height is less than 10 times the distance between the projector and the detector, or (manual) the known height of unobscured portions of abrupt, isolated objects within 1 1/2 miles of a runway.

microbarograph. An aneroid barograph designed to record atmospheric pressure variations of very small magnitude.

millibar. See hectopascal.

minimum temperature. The lowest temperature during a specified period.

nonuniform ceiling. A localized ceiling that varies from the ceiling reported in the body of the SAO.

nonuniform sky condition. A localized sky condition that varies from that reported in the body of the SAO.

nonuniform visibility. A localized visibility that varies from that reported in the body of the SAO.

obscured sky: The condition when the entire sky is hidden by surface-based obscuring phenomena.

obscuring phenomena. Any aggregate of particles aloft or in contact with the earth's surface, dense enough to be detected from the surface of the earth.

observing location. The point or points from which an element is evaluated.

observing station. The point or points from which the various elements of the observation are evaluated.

obstruction to vision. Any phenomenon in the atmosphere, other than precipitation, that reduces the horizontal visibility.

opaque layer. A layer aloft whose ratio (summation at and below the level of the layer) of total opaque to total sky cover is more than one-half.

opaque sky cover. Clouds or obscuring phenomena aloft that shield the sky, higher clouds or obscuring phenomena, or the moon or stars from view.

overcast layer. Civilian: A layer of clouds or obscuring phenomena aloft whose summation amount of sky cover is more than 0.9 to 1.0. Military: A layer of clouds or obscuring phenomena aloft whose summation amount of sky cover is 1.0.

parameter. A subset of the group of evaluations that constitute each element of an observation; e.g., sky condition is an element, sky cover and ceiling are parameters.

partial obscuration. (manual) The condition when surface-based obscuring phenomena hides some but not all of the sky.

peak wind speed. The highest instantaneous wind speed since the last record observation that exceeded 25 knots.

precipitation. Any of the forms of water particles, whether liquid or solid, that fall from the atmosphere and reach the ground.

precipitation discriminator. A sensor, or array of sensors, that differentiates between different types of precipitation (liquid, freezing, frozen).

precipitation intensity. An indication of the rate at which precipitation is falling at the time of observation.

precipitation rate. The amount of water, liquid or solid, that reaches the ground in specified period of time.

pressure. The force exerted by a column of air above the point of measurement.

pressure change. The net difference between pressure readings at the beginning and ending of a specified interval of time.

pressure characteristic. The indication of how the pressure has been changing during a specified period of time, usually the 3-hour period preceding an observation; e.g., decreasing then increasing, pressure same or lower than 3 hours ago.

pressure falling rapidly. A decrease in station pressure at a rate of 0.06 inch of mercury or more per hour which totals 0.02 inch or more.

pressure reduction calculator. A device used to compute sea-level pressure, station pressure, altimeter setting, pressure altitude, etc.

pressure rising rapidly. An increase in station pressure at a rate of 0.06 inch of mercury or more per hour which totals 0.02 inch or more.

pressure tendency. The character and amount of atmospheric pressure change during a specified period of time, usually the 3-hour period preceding an observation.

pressure unsteady. A pressure that fluctuates by 0.03 inch of mercury or more from the mean pressure during the period of measurement.

prevailing visibility. The visibility that is considered representative of conditions at the station.

rain. (automated) Precipitation that remains in the liquid state upon impact with the ground or other exposed objects.

rain. (manual) Precipitation either in the form of drops larger than 0.02 inch (0.5 mm), or smaller drops which, in contrast to drizzle, are widely separated.

rain shower. (manual) Rain that abruptly changes intensity, or abruptly starts and stops.

record observation (SA). A scheduled surface aviation observation.

record special observation (RS). A record observation that also meets the criteria for a special observation.

Remarks. Plain language or coded data added to the surface weather observation to report significant information not provided for in the body of the report.

rotor cloud. A turbulent cloud formation found in the lee of some large mountain barriers. The air in the cloud rotates around an axis parallel to the mountain range.

routine delayed observation (RTD). An observation taken on time but transmitted late.

runway visual range (RVR). An instrumentally-derived value based on standard calibrations that represents the horizontal distance a pilot will see down the runway from the approach end.

SAO transmission schedule. The frequency with which SAOs are given long-line dissemination at a station.

scattered layer. Civilian: A layer whose summation amount of sky cover is 0.1 to 0.5. Military: A layer whose summation amount of sky cover is greater than 0, but not more than 0.5.

scheduled time of observation. The time a scheduled observations is required to be available for transmission.

sea-level pressure. The pressure value obtained by the theoretical reduction or increase of station pressure to sea-level.

sector visibility. The visibility in a specified direction that represents at least a 45 degree arc of the horizon circle.

severe thunderstorm. (augmented and manual) A storm produced by a cumulonimbus cloud that is accompanied by lightning and thunder and by wind gusts of at least 50 knots, and/or hail at least 3/4 inch in diameter.

shall. A term used to indicate that a procedure or practice is mandatory.

sheet ice. Ice formed by the freezing of liquid precipitation or the freezing of melted solid precipitation (see snow depth).

short-term storage. Storage of data for 4 or more days to assist in sensor/system maintenance and verification of sensor/system records in the event of an aircraft mishap.

should. A term used to indicate a procedure or practice is recommended.

significant clouds. Cumulonimbus, towering cumulus, altocumulus castellanus, and standing lenticular or rotor clouds.

single-element special observation. An limited special observation used to convey significant information to users.

sky condition. The state of the sky in terms of such parameters as sky cover, layers and associated heights, ceiling, cloud types, and obscuring phenomena.

sky cover. The amount of the sky which is covered by clouds or obscuring phenomena aloft or hidden by surface-based obscuring phenomena, and is detectable from the point of observation.

smoke. (manual) A suspension in the air of small particles produced by combustion. A transition to haze may occur when smoke particles have traveled great distances; for example, 25 to 100 miles or more, and when the larger particles have settled out and the remaining particles have become widely scattered through the atmosphere.

snow. (automated) Any form of frozen precipitation other than hail.

snow. (manual) Precipitation of snow crystals, mostly branched in the form of six-pointed stars.

snow depth. The vertical height of frozen precipitation on the ground. For this purpose, frozen precipitation includes ice pellets, glaze, hail, any combination of these, and sheet ice formed directly or indirectly from precipitation.

snow grains. (manual) Precipitation of very small, white, opaque grains of ice; the solid equivalent of drizzle.

snow pellets. (manual) Precipitation of white, opaque grains of ice. The grains are round or sometimes conical. Diameters range from about 0.08 to 0.2 inch (2 to 5 mm).

snow showers. (manual) Snow that abruptly changes intensity, or abruptly starts and stops.

special observation (SP): A surface weather observation taken to report a change in weather conditions that meets specified criteria or is otherwise considered to be significant.

squall. A sudden increase in wind speed of at least 15 knots which is sustained at 20 knots or more for at least one minute.

Standard Atmosphere: A hypothetical vertical distribution of the atmospheric temperature, pressure, and density, which by international agreement is considered to be representative of the atmosphere for pressure-altimeter calibrations and other purposes (29.92INS or 1013hPa).

standard time of observation. The time to which a Record observation applies.

standing lenticular cloud. A more or less, isolated cloud with sharp outlines that is generally in the form of a smooth lens or almond. These clouds often form on the lee side of and generally parallel to mountain ranges. Depending on their height above the surface, they may be reported as stratocumulus standing lenticular cloud (SCSL); altocumulus standing lenticular cloud (ACSL); or cirrocumulus standing lenticular cloud (CCSL).

station elevation. The officially designated height above sea-level to which station pressure pertains. It is generally the same as field elevation at an airport station.

station identifier. A three or four alphanumeric code group used to identify the observing location.

Station Information File. A record that documents the site characteristics of a surface weather observing station and the observing program at the station.

station pressure. The atmospheric pressure at the designated station elevation.

summation layer amount. The amount of sky cover at and below a given level.

summation principle. This principle states that the sky cover at any level is equal to the summation of the sky cover of the lowest layer, plus the additional sky cover present at all successively higher layers up to and including the layer being considered.

surface. The horizontal plane whose elevation above sea level equals the field elevation. At stations where the field elevation has not been established, "surface" will refer to the ground elevation at the observation site.

surface aviation observation (SAO). An evaluation from a point or points on or near the ground, according to a set of procedures of those weather elements which are most important for aircraft operations. It may include sky condition, visibility, weather and obstructions to vision, sea-level pressure, temperature, dew point, wind, altimeter setting, and Remarks.

surface aviation observation code. A code consisting of abbreviations, contractions, numbers, plain language, and symbols to provide a uniform means of disseminating weather reports primarily for aviation users.

surface visibility. The prevailing visibility determined from the usual point of observation.

synoptic surface weather observation. Surface weather observations evaluated in accordance with WMO regulations (perhaps modified by national practices). These observations are reported no more frequently than every 3 hours.

temperature. A measure of the hotness or coldness of the ambient air as measured by a suitable instrument.

thin layer. A term applied to a layer, at any level aloft, when the ratio (summation amounts at and below the level of the layer) of total opaque to total sky cover is one- half or less.

thin sky cover. That portion of sky through which higher clouds, blue sky, etc. can be discerned.

thunderstorm. (automated) A storm detected by the occurrence of cloud-to-ground lightning.

thunderstorm. (augmented and manual) A storm produced by a cumulonimbus cloud that is accompanied by lightning and thunder, and does not meet the criteria for a severe thunderstorm.

time of occurrence. A report of the time weather begins and ends.

tornadic activity. The occurrence or disappearance of tornadoes, funnel clouds, or waterspouts.

tornado. (augmented and manual) A funnel cloud that touches the ground (see funnel cloud and water spout).

tower visibility. The prevailing visibility determined from the airport traffic control tower when the surface visibility is determined from another location.

towering cumulus. A descriptive term for a cloud with generally sharp outlines and with moderate to great vertical development, characterized by its cauliflower or tower appearance.

type of observation. A code figure (SA, RS, SP, USP, COR, RTD) included in the surface aviation observation to indicate the content and intended distribution of the observation and to indicate that certain criteria have been met.

type of station. A code figure (AO1, AO1A, AO2, AO2A, AMOS, RAMOS, AUTOB) for automated or augmented stations which is included in the surface aviation observation to indicate the scope of the observation program at the station that generated the observation.

unknown precipitation. (automated) The type of precipitation reported if the automated station detects the occurrence of light precipitation but the precipitation discriminator cannot recognize the type.

urgent special observation (USP). A special observation taken to report tornadic activity or volcanic eruptions. A USP may be shortened to include only the data related to the element requiring the observation.

variable ceiling. A ceiling of less than 3,000 feet which rapidly increases or decreases in height by established criteria during the period of observation.

variable layer amounts. A condition when the reportable amount of a layer varies by one or more reportable values during the period it is being evaluated (variable sky condition).

variable surface visibility. A condition when the prevailing visibility is less than 3 miles and rapidly increases and decreases by 1/2 mile or more during the period of observation.

variable wind direction. A condition when the wind direction fluctuates by 60 degrees or more during the period of observation and the wind speed is greater than 10 knots.

vertical visibility. A subjective or instrumental evaluation of the vertical distance into a surface-based obscuration that an observer would be able to see.

virga. (augmented and manual) Visible wisps or strands of precipitation falling from clouds that evaporate before reaching the surface.

visibility. The greatest horizontal distance at which selected objects can be seen and identified or its equivalent derived from instrumental measurements.

visibility reference points. Selected objects at known distances from the weather station that are used to manually evaluate visibility.

volcanic ash. (augmented and manual) Fine particles of rock powder that are blown out from a volcano and that may remain suspended in the atmosphere for long periods. The ash is a potential hazard to aircraft operations and may be an obstruction to vision or an obscuration.

volcanic eruption. An explosion caused by the intense heating of subterranean rock which expels lava, steam, ashes, etc., through vents in the earth's crust.

water equivalent. The liquid content of solid precipitation that has accumulated on the ground (snow depth). The accumulation may consist of snow, ice formed by freezing precipitation, freezing liquid precipitation, or ice formed by the refreezing of melted snow.

waterspout. (augmented and manual) A funnel cloud that touches a body of water (see funnel cloud and tornado).

weather. A category of individual and combined atmospheric phenomena which must be drawn upon to describe the local atmospheric conditions at the time of observation.

will. A term used to indicate futurity; it is not a requirement to be applied to practices.

wind. The horizontal motion of the air past a given point.

wind character. The description of the variability of the wind speed in terms of gusts and squalls.

wind direction. The true direction from which the wind is moving at a given location.

wind gust. See "gust."

wind shift. A change in the average wind direction of 45 degrees or more which takes place in less than 15 minutes with sustained wind speeds of 10 knots or more.

wind speed. The rate at which air is moving horizontally past a given point. It may be a 2-minute average speed (reported as wind speed) or an instantaneous speed (reported as a peak wind speed, gust, or squall).

wind squalls. See "squall."

APPENDIX B

LIST OF ABBREVIATIONS AND ACRONYMS*

*The abbreviations, acronyms, contractions, and symbols included in this appendix are defined in accordance with their usage in this Handbook.

–	light intensity, sub-zero temperature, thin layer
+	heavy intensity
A	hail
ACSL	altocumulus standing lenticular cloud
AMOS	Automatic Meteorological Observing System
AO1	automated station without precipitation discriminator
AO1A	automated station without precipitation discriminator and an observer signed on
AO2	automated station with precipitation discriminator
AO2A	automated station with precipitation discriminator and an observer signed on
APCH	approach
APPROX	approximately
APRNT	apparent
ATCT	airport traffic control tower
AUTOB	Automatic Observing Station
B	began
BD	blowing dust
BKN	broken
BLO	below
BN	blowing sand
BS	blowing snow
BY	blowing spray
CA	cloud-air lightning
CB	cumulonimbus cloud

CC	cloud-cloud lightning
CCSL	cirrocumulus standing lenticular cloud
cd	candela
CG	cloud-ground lightning
CIG	ceiling
CLR	clear
CONT	continuous
COR	correction to a previously disseminated observation
D	dust
DOC	Department of Commerce
DOD	Department of Defense
DOT	Department of Transportation
DRFTG	drifting
DSIPTG	dissipating
DSNT	distant
E	east, ended, estimated ceiling
F	fog
FAA	Federal Aviation Administration
FIBI	filed but impracticable to transmit
FIRST	first observation after a break in coverage at manual station
FMH-1	Federal Meteorological Handbook No.1, *Surface Aviation Observations*
FMH-2	Federal Meteorological Handbook No.2, *Surface Synoptic Codes*
FQT	frequent
FROPA	frontal passage

G	gust
GF	ground fog
H	haze
HLSTO	hailstone
HOM	station identifier for Homer, Alaska
IC	ice crystals, in-cloud lightning
ICAO	International Civil Aviation Organization
IF	ice fog
INCRG	increasing
INTMT	intermittent
IP	ice pellets
K	smoke
L	drizzle, left (with reference to runway designation)
LAST	last observation before a break in coverage at a manual station
LST	Local Standard Time
LTG	lightning
LWR	lower
M	measured ceiling, missing
max	maximum
min	minimum
MOVD	moved
MOVG	moving
MOVMT	movement
MT	mount

MTNS	mountains
N	north
N/A	not applicable
NCDC	National Climatic Data Center
NE	northeast
NOS	National Ocean Survey
NOSPL	no specials are taken at the station
NOTAM	Notice to Airmen
NW	northwest
NWS	National Weather Service
OCNL	occasional
OFCM	Office of the Federal Coordinator for Meteorology
OMTS	over mountains
OVC	overcast
OVR	over
P	unknown precipitation
PCPN	precipitation
PK WND	peak wind
PRES	pressure
PRESFR	pressure falling rapidly
PRESRR	pressure rising rapidly
Q	squall
R	rain, right (with reference to runway designation), runway
RAMOS	Remote Automatic Meteorological Observing System

RS	Record Special observation
RTD	Routine Delayed (late) observation
RV	reportable value
RVR	Runway Visual Range
RVRENO	RVR values not available for SAO
RVRNO	RVR systems out of service
RW	rain shower
RY	runway
S	snow, south
SA	Record observation
SAO	Surface Aviation Observation
SCSL	stratocumulus standing lenticular cloud
SCT	scattered
SE	southeast
SG	snow grains
SP	snow pellets, Special observation
STN	station
SW	snow shower, southwest
T	thunderstorm
T+	severe thunderstorm
TCU	towering cumulus
TWR	tower
U	unknown precipitation intensity
UNKN	unknown

UNSTDY	unsteady
USP	Urgent Special observation
UTC	Coordinated Universal Time
V	variable
VCNTY	vicinity
VR	visual range
VSBY	visibility
W	indefinite ceiling, west
WG/SO	Working Group for Surface Observations
WMO	World Meteorological Organization
WND	wind
WSHFT	wind shift
X	obscured sky
-X	partial obscuration
ZL	freezing drizzle
ZR	freezing rain

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WORKING GROUP FOR SURFACE OBSERVATIONS (WG/SO)

MR. GERALD F. O'BRIEN, C[illegible]LAGHER
Department of Commerce

MR. STEVE ALBERSHEIM
Department of Transportation

MR. JAMES FAIROBENT
Department of Energy

Offic[illegible]

AD HOC GROUP FOR FE[illegible]D.1 (AHG/FMH-1)

MR. JAMES L. LEHMANN, C[illegible]
Department of Commerce

MR. AUGUST L. SHUMBERA[illegible]
Department of Commerce

LCDR CHRISTOPHER GALL[illegible]
Department of Defense

Offic[illegible]

LCDR DENNIS RUTH
Department of Defense

MSGT MICHAEL SPAULDING
Department of Defense

CMSGT LESLIE O. TAYLOR
Department of Defense

AGC GREG KNOLL
Department of Defense

MR. JAMES B. HARRISON
Department of Commerce

MR. FREDERICK C. HOCHREITER
Department of Commerce

MR. KENNETH KRAUS
Department of Transportation

DATE DUE

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